PRIMUS EPIC

Honeywell

PILOT'S GUIDE

Integrated Avionics and Automatic Flight Control System for the Agusta AW139/AB139 Helicopter

ID-139184

Honeywell

Honeywell International Inc.
21111 N. 19th Ave.
Phoenix, Arizona 85027-2708
U.S.A.
CAGE: 55939
Telephone: (800) 601-3099 (U.S.A.)
Telephone: (602) 365-3099 (International)

TO: HOLDERS OF THE PRIMUS EPIC INTEGRATED AVIONICS AND AUTOMATIC FLIGHT CONTROL SYSTEM FOR THE AGUSTA BELL AB139 HELICOPTER PILOT'S MANUAL, HONEYWELL PUB. NO. A28-1146-160-00.

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HIGHLIGHTS

This guide has been revised to reflect changes and added information to include the AW139. The List of Effective Pages (LEP) identifies the current revision to each page in this guide.

Because of the extensive changes and additions throughout the manual, revision bars have been omitted and the entire manual has been reprinted.

Please replace your copy of this manual with the attached complete revision. The Record of Revisions page shows Honeywell has already put Revision No. 1 dated Apr 2007 in the manual.

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Phoenix, Arizona 85027-2708
U.S.A.
CAGE: 55939

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for the

Agusta AW139/AB139 Helicopter

Pilot's Guide

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1. Introduction

This guide describes the components and operating procedures of the PRIMUS EPIC Integrated Avionics and Flight Control System installed in the Agusta AW139/AB139 Series Helicopter, shown in Figure 1-1.

This guide covers standard and optional equipment installed in the rotorcraft and is divided into the following sections:

Section 1 – Introduction

Section 2 – System Description

Section 3 – Electronic Display System (EDS)

Section 4 – Controllers

Section 5 – Primary Flight Display (PFD)

Section 6 – Multifunction Display (MFD)

Section 7 – Display Reversion

Section 8 – Automatic Flight Control System (AFCS)

Section 9 – Vehicle Monitoring System (VMS)

Section 10 – Radio System

Section 11 – Radio Altitude (RA)

Section 12 – Air Data System (ADS)

Section 13 – Flight Management System (FMS)

Section 14 – Global Positioning System (GPS)

Section 15 – Attitude and Heading Reference System (AHRS)

Section 16 – PRIMUS EPIC 660/700/701 Digital Weather Radar System

Section 17 – Lightning Sensor System (LSS)

Section 18 – Traffic Alert and Collision Avoidance System (TCAS)

Section 19 – Terrain Alert Warning System (TAWS)

Section 20 – Central Maintenance Computer (CMC)

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Figure 1-1
Agusta AW139/AB139 PRIMUS EPIC Integrated Avionics and AFCS Cockpit

EQUIPMENT AND FUNCTIONS COVERED

Honeywell avionics models and systems included in this pilot's guide are listed in Table 1-1. Optional equipment is shown in Table 1-2.

Table 1-1
Standard Equipment

Model	Description	Basic Qty	4 Axis Qty
Automatic Flight Control System (AFCS) Components			
GC-810	Guidance Panel	1	1
PC-770	Autopilot Controller	1	1
	Actuator Input/Output with Processor (AIOP) Module	4	4
SM-7000	Smart Linear Actuator (Pitch)	2	2
SM-7000	Smart Linear Actuator (Roll)	2	2
SM-7000	Smart Linear Actuator (Yaw)	2	2
Modular Avionics Unit (MAU) System Components			
MRC-855A	Modular Radio Unit Cabinet	2	2
NI-900	Network Interface Unit	2	2
VHF Data Radio (VDR) System Components			
TR-865A	VDR Module	2	2
Airborne Audio System Components			
AV-900	Audio Control Panel	2	2
Modular Avionics Unit (MAU) System Components			
RI-553	Remote Instrument Controller	2	2
Air Data System Components			

Table 1-1 (cont)
Standard Equipment

Model	Description	Basic Qty	4 Axis Qty
AZ-200	Air Data Module	2	2
Attitude and Heading Reference System (AHRS) System Components			
LCR-93	Attitude and Heading Reference Unit (AHRU)	2	2
	AHRU Mounting Tray	2	2
	AHRS Calibration PROM	2	2
FX-600	Flux Valve	2	2
Radio Altitude System Components			
RT-300	Radio Altitude	1	1
MT-300	Radio Altitude Mounting Tray	1	1
AT-300	Radio Altitude Antenna	2	2
VOR/ILS/Data Link (VIDL) System Components			
NV-875A	VIDL Module	2	2
Distance Measuring Equipment (DME) System Components			
DM-855	DME Module	1	1
XS-856A	Mode S Diversity Transponder Module	1	1
Flight Management System (FMS) Components			
MC-850	Multifunction Control Display Unit (MCDU)	2	2
Central Maintenance System (CMS) Components			

Table 1-1 (cont)
Standard Equipment

Model	Description	Basic Qty	4 Axis Qty
CMC-901	Central Maintenance Computer (CMC) Module	1	1

NOTE: The basic instrument flight rules (IFR) FAA certification comes with four DU-1080s and the basic European Space Agency (EASA) and Ecole Nationale de l'aviation Civile (ENAC) certification comes with three DU-1080s.

Table 1-2
Optional Equipment

Model	Optional Equipment	Qty.
Airborne Audio System Optional Components		
CA-900	Cabin Audio Controller	1
Modular Avionics Unit System Optional Components		
VID-100	Video Control I/O Module	1
Radio Altimeter Optional Components		
RT-300	Radio Altimeter	2nd
RT-300	Radio Altimeter Mounting Tray	2nd
AT-300	Radio Altimeter Antenna	up to 4
P-660 Weather Radar (WXR) Optional System Components		
WU-660	Receiver/Transmitter Antenna	1
WC-660	Weather Radar Controller	1
P-700/701 Weather Radar Optional System Components		
WA-700	Antenna Pedestal	1
FP-900	Flat Panel Antenna	1
WR-701	Receiver/Transmitter	1
	Tray for WR-700 Receiver/Transmitter	1
WC-700	Weather Radar Controller	1
WC-701	Beacon Controller	1
Lightning Sensor System (LSS) Optional Components		
LP-860	Lightning Processor	1
LU-860	Lightning Sensor Controller	1
MT-850	Lightning Processor Mounting Tray	1
AT-850	Lightning Sensor Antenna	1
Distance Measuring System Optional Components		

Table 1-2 (cont)
Optional Equipment

Model	Optional Equipment	Qty.
DM-855	DME Module	2nd
Air Traffic Control Transponder System Optional Components		
XS-856A	Mode S Diversity Transponder	2nd
Automatic Direction Finder Optional System Components		
DF-855	ADF Module	2nd
AT-860	ADF Antenna	2nd
Global Positioning System (GPS) Optional Components		
GPS-90X	GPS Module	1
GPS-Ant	GPS Antenna	1

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2. System Description

INTRODUCTION

ARCHITECTURE

A block diagram of the Honeywell PRIMUS EPIC system for the instrument flight rules (IFR) version of the Agusta AW139/AB139 helicopter is shown in Figure 2-1. The system includes the following major functions:

- Electronic display system (8x10, Qty 4)
- Monitor warning system
  - Crew alerting system (CAS)
  - Aural warning system
- Automatic flight control system
- Radio and audio system
  - Internal communications system (ICS)
  - Communication VHF and HF
  - Navigation
  - Transponder
  - Traffic alert and collision avoidance system (TCAS) (option)
  - Global position system
  - Radio altitude system (option for dual)
- Flight management system
- Controllers
- Air data system
- Attitude and heading reference system
- Weather radar system (option)
- Lightning sensor system (option)
- Maintenance system
- Enhanced ground proximity warning system (option).

The system is available in two basic versions: instrument flight rules (IFR), and search and rescue (SAR). The SAR version adds equipment and functions necessary to conduct SAR operations. There are two dominant architectural aspects of the PRIMUS EPIC system:

- Virtual backplane TM network
- Modular avionics unit (MAU) architecture.

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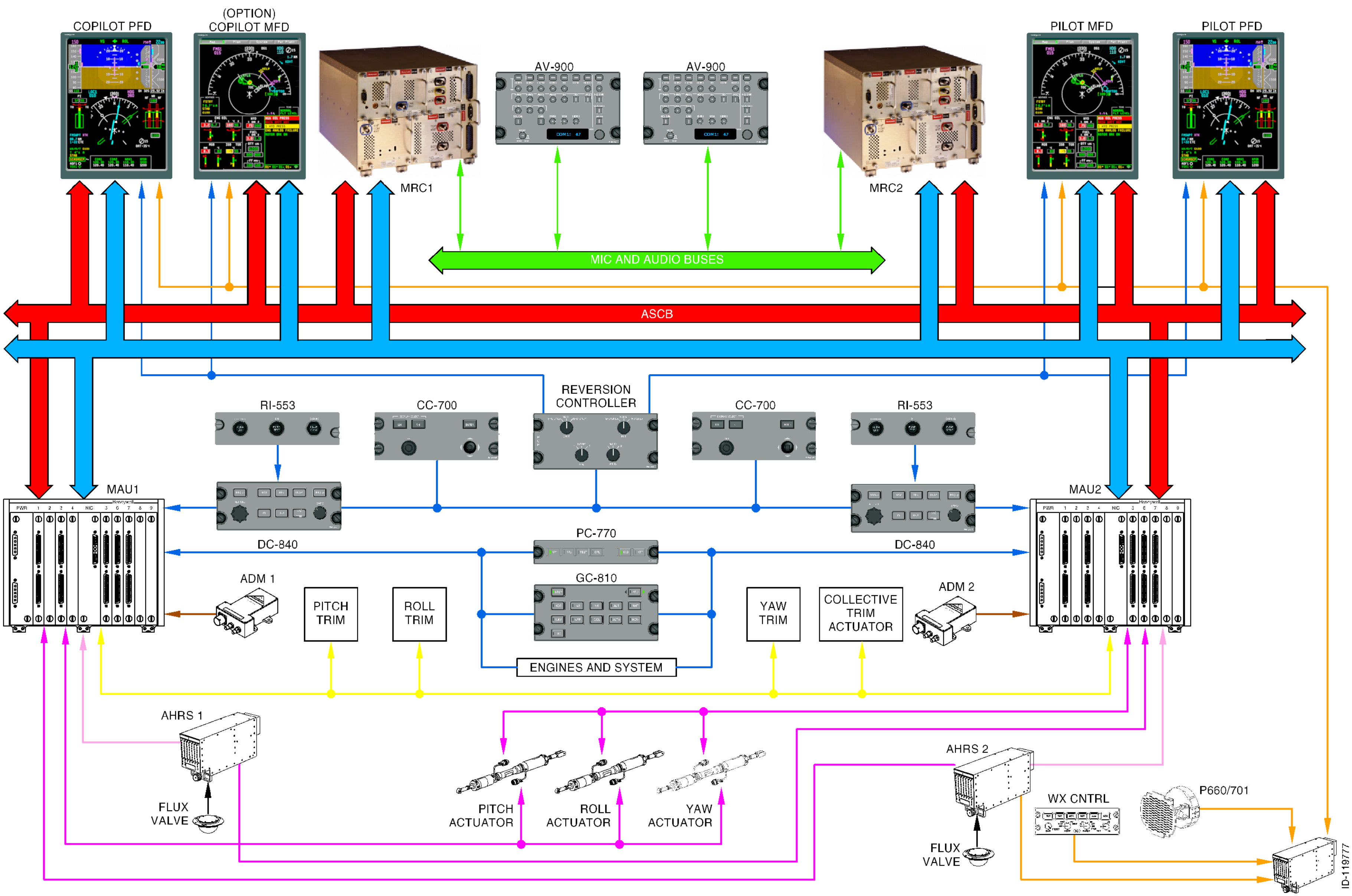

Figure 2-1
System Block Diagram

VIRTUAL BACKPLANE NETWORK ARCHITECTURE

Physically, the Virtual Backplane Network consists of the high-integrity aircraft-wide bus network called the ASCB-D (avionics standard communication bus - digital) and the software and hardware mechanisms within the units that communicate on ASCB-D. In the PRIMUS EPIC system, the modular avionics unit (MAU), display units (DUs) and modular radio cabinets (MRC) are directly attached to the ASCB-D.

The ASCB-D network permits up to critical integrity and availability for data communications between these units. Each ASCB-D bus gives high capacity (10 Mb/sec) data throughput, and uses tapped twin-axial wire. Similar to the older version of the ASCB-C used in previous Honeywell systems, the ASCB-D network consists of four buses for system redundancy requirements. The ASCB-D design and protocols ensures that all four buses remain synchronized and deterministic at the ASCB data transmission rates of 80, 40, 20, 10, 5, and 1 Hz.

Along with the ASCB-D bus network, an additional local area network (LAN) is included. The LAN is based on Ethernet 10-base-2 and is available to every unit that attaches to the ASCB-D. The LAN is a nonessential (availability) bus, and is used on the AW139/AB139 system for data loading, maintenance and test purposes. An off-the-shelf laptop computer configured as a maintenance terminal (Ethernet 10-Base-2 hardware and Honeywell software) can be connected to the LAN to perform maintenance and data loading functions.

Every unit attached to the ASCB-D (including any potential non-Honeywell units) uses a common interface called a network interface controller (NIC). The NIC gives a high integrity method for the unit to interface to ASCB-D, permitting the unit to exchange data between the ASCB-D and the internal modules or circuit cards. In this description, circuit cards and modules are terms being used interchangeably, however, both must be backplane compatible. The NIC design is available for use by non-Honeywell suppliers to permit third party units to interface to the ASCB-D in a safe and certifiable manner. Figure 2-2 is a diagram of the ASCB-D and LAN bus networks for the AW139/AB139 EPIC system.

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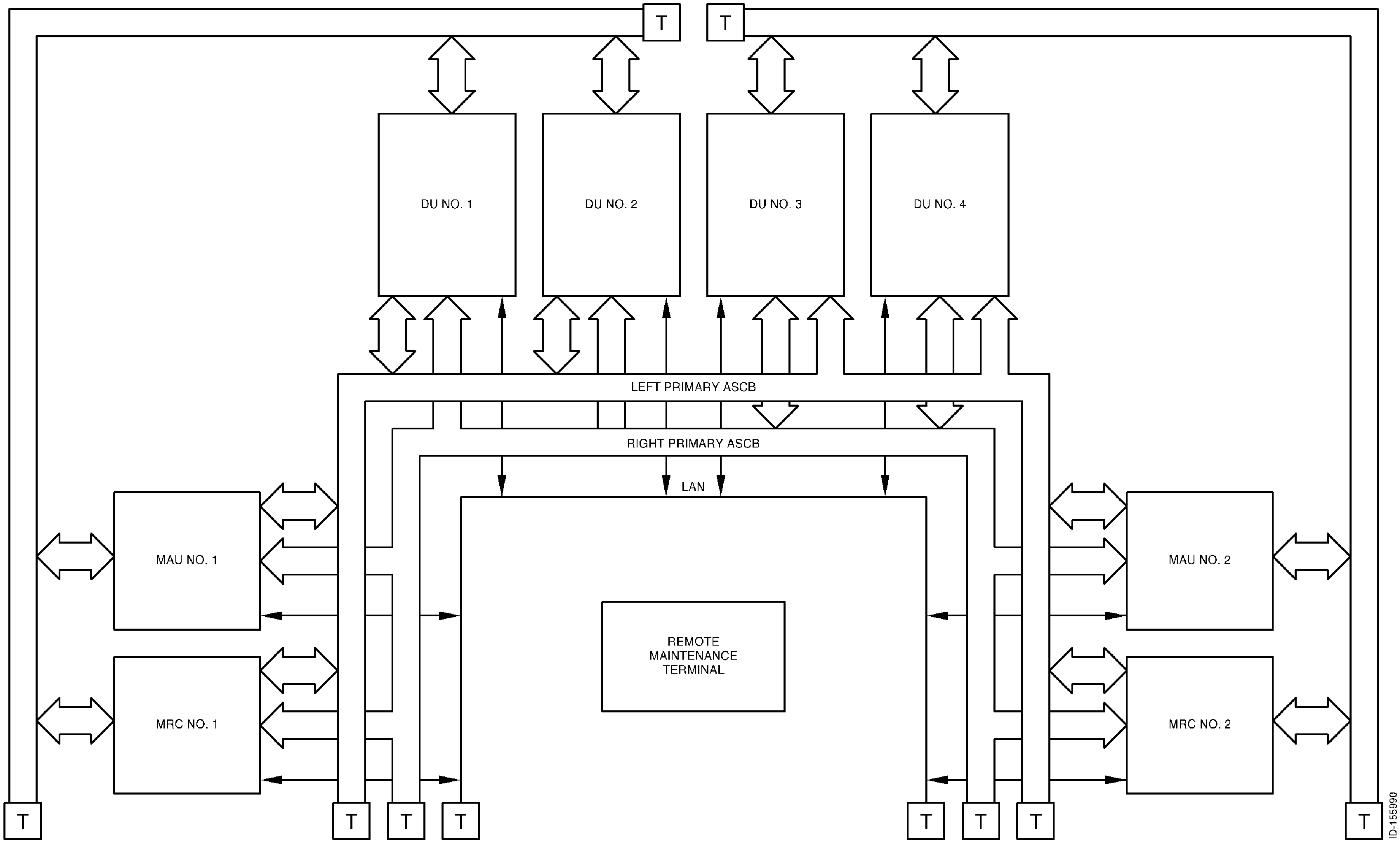

Figure 2-2
ASCB-D and LAN Block Diagram

MODULAR AVIONICS UNIT (MAU)

The modular avionics unit (MAU) consists of a cabinet that houses a variety of line replaceable modules. An MAU can consist of a variable number of **user slots** (slots not including the power supply or NIC modules), and can be single or dual channel. An MAU channel consists of a power supply module, NIC, an MAU data communications backplane and various modules connected to that backplane. Dual channel MAUs contain dual separate NICs and backplanes and are powered by independent power supply modules.

The MAUs generally house the digital engine operating system (DEOS) compliant processing, I/O, and network interface modules, and communicate with each other by way of the ASCB and LAN buses. The generic I/O, custom I/O, control I/O, and the actuator IO processor (AIOP) modules input the various sensor and system data to processor modules that perform the actual aircraft control and monitoring calculations.

Communication within the MAU is managed by the NIC. The NIC transmits and receives the ASCB and LAN data and makes this data available to client modules within the MAU by way of a modified peripheral component interconnect (PCI) backplane known as the virtual backplane peripheral component interconnect bus, or VbPCI. The VbPCI bus is a 32-bit wide passive parallel backplane bus. It is used to connect the NIC to all modules with the exception of the power supply module and the GPS module. The NIC transmits the data from all modules within the MAU on the ASCB and all module data within these units, including I/O, is available to any other module or the ASCB-D unit in the entire PRIMUS EPIC system.

Connection to the MAUs VbPCI backplane is given by a standard hardware interface called the backplane interface controller (BIC). The BIC is physically resident on client modules and gives the ability for the NIC to stage received ASCB and LAN data to the client module. It permits the NIC to retrieve ASCB and LAN data that the client module wishes to transmit. The hardware mechanism for this data staging is known as the BIC frame buffer. The BIC frame buffer is a dual-port RAM that can be read and written to by both the NIC and the client module.

In order to decode/encode data to and from the BIC, MAU modules use a software function hosted on the module processing. For most of the MAU modules, this is a standard function called the periodic device driver (PDD). The PDD is a high-integrity table-driven routine that distributes the ASCB-D data to software applications hosted on the modules in synchronization with the ASCB-D network.

Each module in the MAU has read/write capability to primary and backup buses on the same ASCB channel, and has read capability from only the opposite side primary ASCB channel. This is shown in Figure 2-2. A single-sided arrow in this figure indicates capability to read a particular bus. A double-sided arrow indicates capability to read and write to that bus.

Figure 2-3 shows a diagram of the MAU architecture.

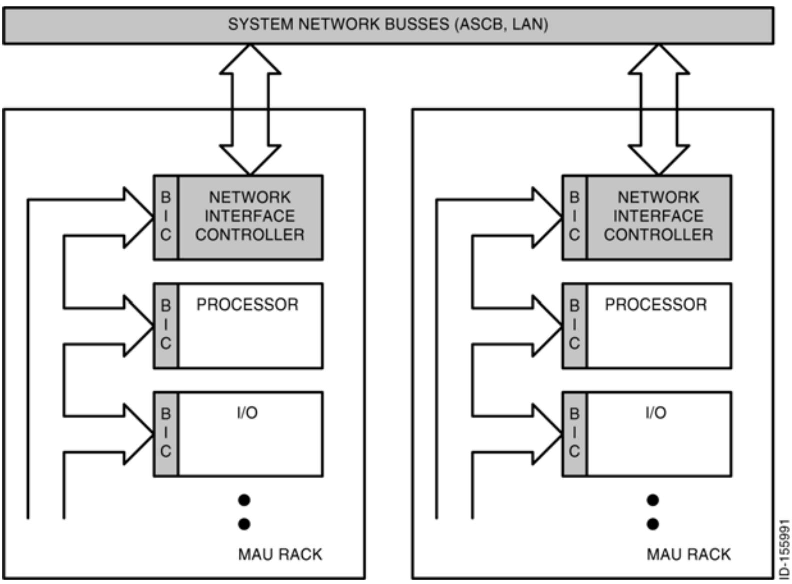

Figure 2-3
Virtual Backplane Network

The MAU is a cabinet that houses line replaceable modules. The AW139/AB139 system includes two single channel MAUs. Each MAU gives slots for nine user modules together with a NIC and a power supply. Many different module types are available for the MAU. The following is a list of some of the currently available MAU modules:

- Power supply (PS)
- Network interface controller/processor (NIC/PROC)
- Processor (PROC)
- Actuator IO processor (AIOP)
- Database (DB)
- Generic I/O (GIO)

- Global positioning system (GPS)
- Custom I/O (CSIO)
- Control I/O (CIO)
- Control/video I/O
- Central maintenance computer (CMC).

The modules consist of a conformal-coated circuit card and electronics, backplane connectors, front mounting plate and front connector(s) (when appropriate). The complement of modules and layout for the AW139/AB139 configuration for each MAU are shown in Figure 2-4. Descriptions of each of the MAU modules are given in the following paragraphs.

SLOT #	PCI #	MAU 1 (218) (LEFT - COPILOT)
9	24	CMC
8	23	AIOPB1 (AFCSB1, ADS1)
7	22	
6	21	AIOPA1 (AFCSA1, SCMS1)
5	20	
	28	PROC1 (MWS1, FMS1)
		NIC1 (ID1:HCMS10)
4	10	VIDEO (OPTION)
3	11	CIO1 OR OPTION CIO/VIDEO (CAL1)
2	12	CSIO1
1	13	
		POWER SUPPLY 1

SLOT #	PCI #	MAU 2 (219) (RIGHT - PILOT)
9	24	GPS
8	23	AIOPB2 (AFCSB2, ADS2)
7	22	
6	21	AIOPA2 (AFCSA2, SCMS2)
5	20	
	28	PROC2 (MWS2, FMS2)
		NIC2 (ID33:HCMS20)
4	10	DBM
3	11	CIO2 (CAL2, AW)
2	12	CSIO2
1	13	
		POWER SUPPLY 2

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Figure 2-4
Modular Avionics Unit Configuration

NOTES:

1. MAU slots identified as being occupied by optional hardware must have an air management module installed when the optional hardware is not present.
2. The CMC is not required for flight and can be replaced by an air management module.

SYSTEM COMPONENTS

The following paragraphs describe the major components shown in Figure 2-4.

Modular Avionics Unit (MAU)

CABINET

The MAU cabinet is used to house the MAU modules. It contains a passive backplane, card guides, and cooling fans. The AW139/AB139 cabinet has slots to support a single power supply, single NIC/PROC and nine user modules. The nine user slots are physically identical, however, the slots for the power supply and NIC/PROC are unique to these modules. The MAU slots are designed to prevent insertion of a module type that would result in physical damage to the module or the backplane. For example, installing a NIC card into a power supply slot would be prevented. Mechanical keying is not used to prevent installation of a user module in the wrong slot. Rather, protection against interchange of user modules are controlled through the configuration monitoring function

POWER SUPPLY

The power supply uses aircraft 28 V dc power to create conditioned power for the MAU modules. Two 28 V dc inputs are available to permit connection to up to two aircraft power buses (one of which can be a battery). The two power inputs are simply diode isolated and so the MAU draws power from the input that has the higher voltage.

NETWORK INTERFACE CONTROLLER/PROCESSOR (NIC/PROC)

All data communication between modules and ASCB/LAN is managed by the NIC. The NIC module takes up the equivalent of two user slots in the MAU cabinet. In addition to the NIC functionality, the module gives functionality equivalent to a processor module

The primary purpose of the network interface controller (NIC) module is to give a gateway for MAU modules to access the ASCB-D and LAN to give synchronization of the ASCB-D network. Other functions in the NIC include:

- Broadcasting system configuration
- Provision of time/date to the system

- Checking channel configuration
- Initiation of power-up check of the power module monitoring
- Monitoring MAU fan operation.

The NIC module includes a second processor that can be used to host user applications. This processor, does not use up an additional user slot and can be treated just like any other dedicated processor module.

PROCESSOR (PROC)

The processor is the brains of the MAU. The module initially uses an INTEL PENTIUM II processor. This can be upgraded over the life of the program as appropriate. The processor uses the DEOS. Through the use of time (processor time) and space (memory and I/O) partitions, DEOS permits multiple software applications with various levels of criticality to execute on the same processor. Typical functions by the processors (NIC/PROC and PROC) include:

- FMS
- Monitor warning
- AFCS
- Air data.

NOTE: The AW139/AB139 configuration does not currently use a stand-alone processor module. While a processor module can be added when required to support growth functions, the current processing requirements are met using the processors embedded in the NIC and AIOP modules.

CUSTOM I/O MODULE

The custom I/O module transfers external input/output data onto and off from the ASCB-D network (by way of the MAUs VbPCI backplane) using I/O translation routines. The custom I/O module is composed of two circuit cards sandwiched together. The custom I/O module occupies two physical MAU slots, however, it uses the electrical interface with the VbPCI backplane in only one of these two slots.

The main circuit card in the custom I/O module is a generic I/O card that gives a standard mix of ARINC 429 and discrete and analog I/O interfaces. Processing in the generic I/O card is given by an Intel 80486 microprocessor, and this processor uses DEOS (synchronized to ASCB-D) and the PRIMUS EPIC core software components.

The second circuit card in the custom I/O is designed specifically for the AW139/AB139 to give additional or custom interfaces not available on the generic I/O card. This specialized I/O circuitry is connected to the generic I/O card by way of a mezzanine connector. Control of the hardware on the custom I/O card is given by the processor on the generic I/O card.

CONTROL I/O MODULE

Control I/O modules are similar to the previously mentioned I/O modules, using Intel 80486 processing. The control I/O modules are specialized by containing controller specific interfaces (such as interfaces to the system display controllers, CCDs and the MCDUs. In addition, the control I/O module hosts aural warning circuitry that produces aural alerts in the cockpit.

VIDEO MODULE (OPTION)

The video module is based on a control I/O module, but adds a second circuit card that is used to convert analog video to digital video for transmission to the displays by way of the digital remote image bus (RIB). The processor on the CIO circuit card performs control of the video card functionality. The video module is an option in the AW139/AB139. It can be installed in place of the MAU1 CIO module and takes up the normally vacant slot adjacent to the MAU1 CIO module.

The video module can be used to support installation of a forward looking infra-red (FLIR), search radar, aircraft monitoring cameras (rear vision, baggage compartment, upper deck, cargo hook) or other video source. The video I/O module gives interfaces for a variety of video sources. The video module supports up to eight sources of video. The video module can display multiple video sources simultaneously, each in a small window, with reduced update rates. This mode can be used to select one source of video which, when selected, is displayed in a larger window.

ACTUATOR I/O PROCESSOR MODULES

The actuator I/O processor (AIOP) module gives processing for the AFCS functions and interfaces for the linear actuators, trim actuators, and position sensors. The PRIMUS EPIC system for the AW139/AB139 includes six **smart** linear actuators, two in each of the pitch, roll, and yaw axes. Each AIOP module interfaces to three linear actuators, one in each of the above axes. The AIOP modules in each MAU interface to three or four rotary actuators (pitch, roll, and yaw trim with an option for a collective parallel actuator). Pulse width modulated (PWM) commands are given by the AIOP modules to control the rotary actuators.

The actuator I/O with a processor module is a dual slot, single lane module that consists of two interconnected circuit cards (I/O card and processor card). The I/O card contains no software and the processor card communicates directly with I/O card by way of the peripheral component interface (PCI) local bus. The I/O is primarily dedicated to actuator control, excitation/demodulation of position sensors and control of functional enable and disable control lines.

The module gives 28 V dc power inputs through the front connectors for the 28 V dc/open outputs and trim outputs for conventional trim actuators. Power for the processor and other core functions is obtained from the MAU backplane.

Processing in the AIOP module is given by an INTEL PENTIUM II and this processor utilizes DEOS and the PRIMUS EPIC core software components (boot, LAN device driver, PDD, Core BIT, fault history manager and file system).

The architecture of the AFCS system requires a minimum of two actuator I/O with processor modules for engaged operation. The two AIOPs give two independent paths for command and monitor application of actuator control authority. The two AIOPs are hardware identical, differ in functionality, handle separate, complementary, and similar functions. The AFCS installation in the AW139/AB139 requires that two AIOP modules be installed in each MAU (total of four AIOP modules).

CMC MODULE

The CMC module is primarily used for hosting the central maintenance computer (CMC) function in PRIMUS EPIC, but can be used for general purpose functions such as data loading. This module is similar to other modules in that it has a BIC hardware interface (for accessing ASCB-D data). However, the module uses the WINDOWS NT operating system. Processing is handled by an INTEL PENTIUM II processor.

DATABASE MODULE

The database module gives a central resource for storing data. In the AW139/AB139 configuration, it is currently used to store a backup of the MAU flight software and maintenance database. Storage of the backup copy of the flight software is used to support loading of software when a field loadable module is replaced.

GPS MODULE (OPTION)

The GPS module interfaces to an active antenna and gives GPS data on the ARINC 429 and interfaces by way of a front connector. The initial version of the module gives performance appropriate for en route operation and nonprecision approaches. As future options, the GPS module will be fully compatible with the wide and local area augmentation systems (WAAS and LAAS).

MODULAR RADIO CABINET (MRC)

The modular radio cabinet (MRC) consists of a cabinet that houses multiple line replaceable modules providing aircraft radio functions. Each MRC communicates to the rest of the PRIMUS EPIC system by way of the ASCB-D and LAN networks. The radio modules consist of metal-enclosed circuit cards, backplane connectors, a front mounting plate, and front connector(s). Each radio module contains its own power supply. The layout of the AW139/AB139 modular radio cabinets is shown in Figure 2-5.

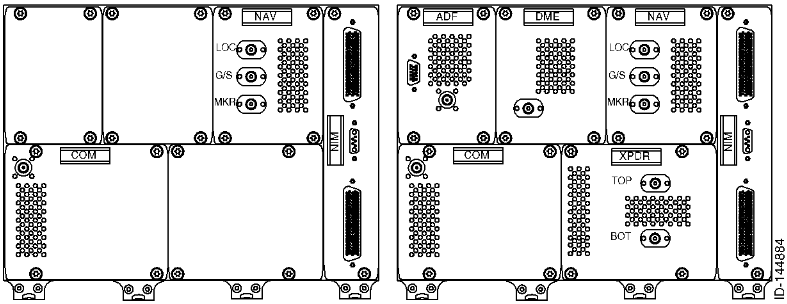


Figure 2-5
Modular Radio Cabinet

The cabinet contains the following components:

- **NI-900 NIM Module** - A module that consists of two sections: a NIC section and a central cabinet processing section. The NIC section consists of the standard NIC circuit as used on all other ASCB-connected units. The central cabinet processing section uses an Intel 80486 processor, DEOS (synchronized to ASCB-D) and PRIMUS EPIC core software components. This section processes commands from the ASCB-D (such as radio tuning commands), formats all radio frequency (RF) module data for transmission on the ASCB-D, and gives various additional tasks such as audio data handling. The NIM connects internally to the radio modules by way of a passive, serial backplane based on the RS-422. The NIM contains its own power supply.

- **NV-875A VIDL Module** - The NV-875 VIDL gives VOR/ILS and datalink functionality. It contains a VOR/LOC receiver, GS receiver and a marker beacon receiver. The datalink function uses the VOR receiver to obtain data such as DGPS correction data for transmission to the GPS receiver. The datalink function is not currently implemented for the AW139/AB139 and is given for growth.

- **DF-855 ADF Module** - The DF-855 ADF (automatic direction finder) contains an ADF receiver that enables en route and terminal navigational and area guidance.

- **DM-855 DME Module** - The DM-855 DME (distance measuring equipment) contains a DME receiver that enables en route and terminal navigational and area guidance.

- **TR-865 COM Module** - The TR-865 COM (communication) contains a COM transceiver that gives air traffic control two-way air to air and air to ground AM voice communication. The radio can be tuned in the range 118 to 137 MHz in 8.33 kHz increments. Although not currently implemented in the AW139/AB139, the TR-865 can be upgraded to give digital voice and two-way data communication in Mode A and Mode 2. The TR-866 (option) is available to support an extended tuning range up to 152 MHz.

- **XS-856A XPDR Module** - The XS-856A XPDR (transponder) contains a transceiver that gives air traffic control radar beacon system (ATCRBS), Mode S and diversity transponder capability.

Display Unit

The liquid crystal display (LCD) unit, shown in Figure 2-6, is the primary medium for giving flight, navigation, engine, aircraft systems and caution/warning related information to the flight crew. The basic system comes with four displays, the pilot and copilot each have a primary flight display (PFD) and multifunction display (MFD).

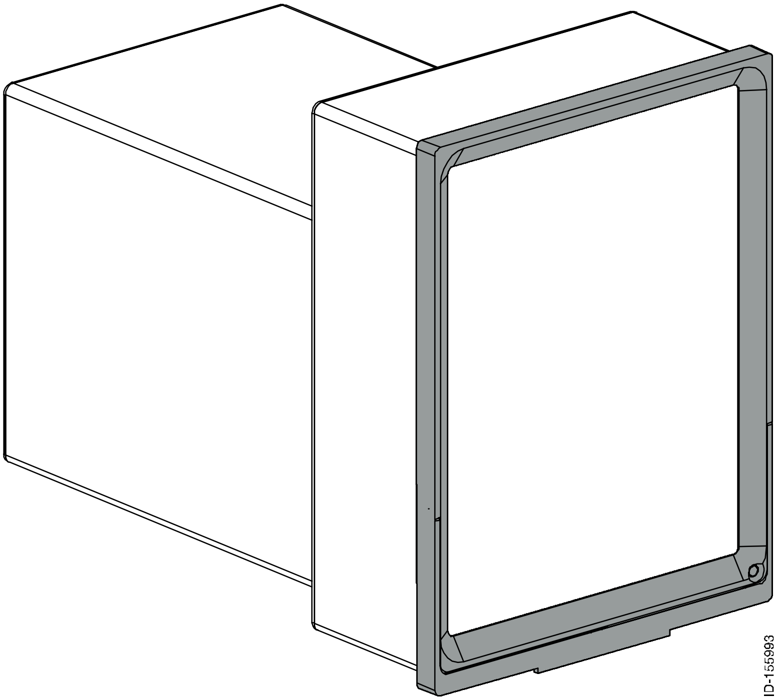


Figure 2-6
Display Unit

PRIMUS EPIC DUs are **smart displays** that contain autonomous processing capability and are directly connected to the ASCB-D and LAN networks. Multiple units are used in the aircraft to display the required information and to give sufficient redundancy. Each DU contains the following components:

- **NIC Circuitry** - The standard connection circuit to the ASCB-D and LAN networks.

- **Main Processor** – Consists of an INTEL PENTIUM II processor using DEOS (synchronized to ASCB–D) and a set of DU core software which makes extensive re–use of the PRIMUS EPIC MAU core software components. This processor executes functions specific to the unit including I/O handling and core graphics generation. In addition, the unit can host other system functions such as graphics generation and display control functions.

- **I/O** – Consists of hardware that interfaces to the ARINC 429 and discretes.

- **Backplane Bus** – A parallel data bus that ties together the NIC circuit, main processor and I/O within the DU.

- **Combiner and LCD** – Interfaces to the main processor and external video buses to give graphics display.

- **Lamp and Lamp Power Supply/Dimmer** – This is a restate power dimmer switch.

CONTROLLERS

Display Controller

The display controller, shown in Figure 2-7, is a device that interfaces to the control I/O modules in the MAUs and is used by the display control function for mode information. Data from the display controller is transmitted to the control I/O module in the MAU by the way of a serial bus. In addition, the display controller interfaces with the CCD and remote instrument controller (RIC) and transmits data from these controllers by the way of the serial bus.

Figure 2-7
Display Controller

The baro knob is used to control the barometric setting for the air data function. The altitude select knob is used to control the altitude preselect bug. The **BRG** circle and **BRG** diamond buttons are used to toggle through the available bearing pointer navigation sources. Possible bearing sources include ADF, variable omnidirection and ranging (VOR) or direction finder (DF) (when installed). The **NAV** button toggles the selected NAV sources on the HSI through the available short-range navigation sources. The **LNAV** button toggles the selected NAV source on the HSI through the available long-range navigation sources. When the **LNAV** button is pushed, when no FMS is installed, the previous selected NAV source remains and a CAS message is displayed for five seconds. The CAS message alerts the pilot that the FMS function is not installed. The **PRV** button can be used when an LNAV source is currently displayed to preview any of the short-range navigation sources. Currently, when FMS is the displayed NAV source, the **PRV** button toggles through VOR/ILS1, VOR/ILS2 and OFF. The HSI button is used to toggle the HSI through the following possible formats:

- 360°
- Hover
- ARC.

The **MAP** button toggles display of the HSI stick map ON and OFF. When the HSI is not already in ARC mode and the **MAP** button is selected, the ARC mode is displayed. The **WX** button toggles the display of the weather radar ON and OFF. As with the **MAP** button, selection of the **WX** button selects the ARC mode for the HSI.

Cursor Control Devices (CCD)

The cursor control device (CCD), shown in Figure 2-8, is used to control the cursor and scroll data such as CAS messages, ranges or frequencies on the DUs. The unit contains no software or processing capability. The button and gray code SET knob on the CCD are wired to the display controller and transmits the CCD data to the control input/output (CIO) module by way of a serial bus.

The display select buttons on the CCD are used to select which display the CCD controls. The joystick is used to move the cursor on the selected display. The **ENTER** button is used to select an item currently highlighted by the cursor. The two concentric SET knobs are used to adjust parameters selected by the cursor. Examples of items can be controlled using the set knob including the scrolling of CAS messages, selection of display range, and radio tuning.

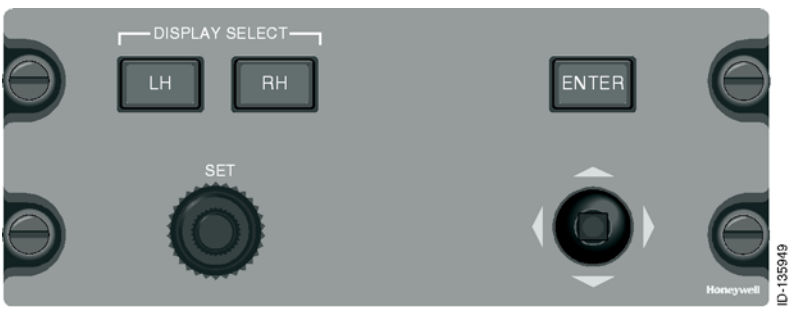


Figure 2-8
Cursor Control Device

Remote Instrument Controller (RIC)

The remote instrument controller, shown in Figure 2-9, is a device that operates in conjunction with the display controller and is used to set the course, decision height, and heading. The controller consists of three gray code knobs and three discrete buttons that are connected to the display controller. It contains no software or processing capability. The course knob is used to control the course pointer on the HSI. When a VOR is selected as the current NAV source, pushing the button in the center of the course knob sets the course pointer to a course that is direct to the VOR ground station. The DH knob is used to set the decision height on the PFD. The center button on the DH knob activates the built-in test function of the radar altimeter. The heading knob controls the heading bug on the HSI. The center button on the heading knob can be used to synchronize the heading bug to the current aircraft heading.

Figure 2-9
Remote Instrument Controller

Guidance Controller

The guidance controller, shown in Figure 2-10, is a device that interfaces to the control I/O modules in the MAUs and is used by the display control and AFCS functions for mode information. Communication with the control I/O module in the MAU is by way of a RS422 serial interface.

The **PFD** select button is used to select which PFD is coupled to the flight director. The coupled annunciation shows annunciator arrows that point toward the coupled side. The **STBY** button is used to turn off any currently selected flight director mode. The remaining buttons on the guidance controller are used to select the corresponding flight director mode.

Figure 2-10
Guidance Controller

Autopilot (AP) Controller

The autopilot controller, shown in Figure 2-11, is used to turn the autopilot function ON and OFF, select modes and perform preflight tests. The controller consists of six buttons with integral annunciators. The buttons are connected to the actuator I/O and control I/O cards in the MAU and to the guidance controller. The autopilot controller contains no software or processing functionality.

The **AP1** and **AP2** buttons enable the corresponding AFCS. The **TEST** button starts the AFCS initiated BIT test. The **CPL** (couple) button is used to manually toggle ON and OFF the coupling of the flight director to the autopilot. The default state is for the flight director to be coupled to the autopilot. The **SAS** and **ATT** buttons are mutually exclusive and are used to select the SAS or Attitude modes of operation of the AFCS.

Figure 2-11
Autopilot Controller

Multipurpose Control Display Unit (MCDU)

The MCDU, shown in Figure 2-12, is a keyboard control/display device that gives general-purpose control and display for several functions in the aircraft such as FMS and radios.

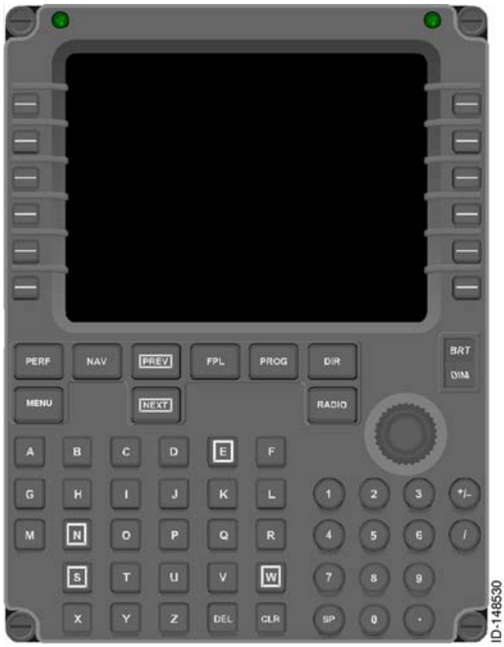


Figure 2-12
Multipurpose Control Display Unit

Each MCDU is connected to a control I/O module (in the MAUs) which implements the protocols and interfaces required to communicate with the rest of the PRIMUS EPIC system. The MCDU gives a backup radio tuning function. This function permits the MCDU to directly tune the on-side radios by way of the ARINC 429.

MCDUs internally contain INTEL 80486 processors, DEOS (internally synchronized) and PRIMUS EPIC core software components. Additionally, they contain keyboard and display routines specific to the MCDU.

The full-color LCD display in the MCDU has 14 lines of text, 24-characters long. The top line of the MCDU display is a dedicated title line. The bottom display line is used as a scratchpad and to display messages. The full-color display in the MCDU makes the presentation much more readable by using different colors for lateral and vertical information. Data and titles on the screen are different colors to increase the differentiation and, therefore, the readability. The color MCDU aids in reducing learning time and cockpit errors.

A manual dimming control adjusts long-term display brightness levels. Ambient light sensors adjust short-term display brightness for varying cloud/sunlight conditions.

Audio Panel

The audio panel, shown in Figure 2-13, receives digitized audio from the MRCs by way of two high-speed digital audio buses. Each audio panel selects the correct channels from the digital audio buses and produces analog headphone and speaker signals.

Figure 2-13
Audio Panel

In addition to the radios integrated into the MRC, the audio system can receive digital audio from nonintegrated radios such as a HF COMM. This is done by wiring the analog audio output from this nonintegrated radio to one of the MRCs where its signal is digitized and transmitted on the digital audio bus.

Microphone audio is digitized by the audio panel and transmitted by way of the digital microphone bus to the two MRCs and any other audio panels. The audio panel contains microphone selection buttons that can be used to direct which radio the microphone output must be transmitted to. For nonintegrated radios, the microphone signal is converted back to an analog signal and transmitted to the radio by the NIM in the MRC.

The buttons on the first row of the audio panel are microphone selection buttons. Selecting these buttons is mutually exclusive. The second, third and fourth rows of buttons give audio selection and volume control for each of the radios.

NOTE: The FONE microphone selection is for a full duplex communication device such as a SATCOM and does not have an audio selection button that is independent of the microphone. When a SELCAL call is received by any of the radios configured to receive SELCAL, the **SELCAL** button and the corresponding microphone button for that radio flashes.

The **circular** button below the **PA** microphone button is used to control the volume of the PA output to the cabin. The **MUSIC** button is used to toggle ON and OFF and control the volume for audio from a cabin entertainment system. The **CHM1** and **CHM2** buttons are used to transmit a chime signal to the cabin speakers. When toggled on, these buttons set a discrete that can be used to control a visual cabin annunciator.

The **CAB** button selects and controls the volume for the CABIN ICS. When the **PILOT** button is pushed on the cabin audio controller, the **CAB** button on the pilots' audio panels flash to indicate the crew is being paged on the cabin ICS.

The **INPH** button selects and controls the volume for the PILOT ICS. The **VOX** button is used to control the sensitivity of the VOX system. The **HDPH** button is used to control the master volume for the pilot headset. The **VOL** button is a generic set knob that is used to control volumes in conjunction with the buttons for the respective radios.

When the **BKUP** button is toggled to the raised state, the headset normally connected to the audio panel is directly connected to the off-side audio panel to give a backup ICS function. Pushing the **PTT** (push to talk) button connects the microphone of the pilot to the on-side COM radio.

Cabin Audio Controller

The cabin audio control panel, shown in Figure 2-14, is an auxiliary audio panel that is intended for use by a single cabin operator. The cabin audio controller includes a headset jack that is interfaced to one of the auxiliary MRC analog headset and microphone interfaces. Button commands from the cabin audio controller are transmitted by way of a bi-directional serial bus to the audio panel. From the audio panel, they are transmitted by way of the microphone bus to the MRC to control the cabin operators headset audio.

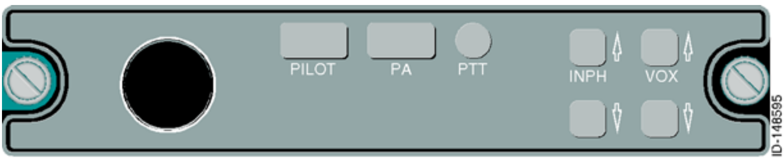


Figure 2-14
Cabin Audio Controller

Pushing the **PILOT** button, pages the pilot by flashing the **CAB** button on that audio panel. When the pilot pushes the **CAB** button, the cabin operator is connected to the pilot ICS permitting communication between the cabin and the pilots. The cabin operator headset volume can be controlled using the **INPH** buttons with the up and down arrows controlling the volume in the corresponding manner. The **VOX** buttons are used to control the sensitivity of the VOX function for the cabin operator. The **PA** button is used to enable the PA system. The **PTT** button is used to permit the cabin operator to talk on the PA.

ACTUATORS

Smart Linear Actuator

The EPIC AFCS performs primary control of the aircraft about the pitch, roll, and yaw axes by way of linear actuators mounted in series with the pilot-side controls. Six linear actuator units are required for the AW139/AB139 installation, comprising a dual actuator system. Each tri-axial set (pitch, roll, yaw) of actuators interfaces electrically to a single autopilot system.

The linear actuator is powered directly from the aircraft power bus. It is controlled by the MAU by way of a digital controller area network (CAN) bus. The smart linear actuator includes a microprocessor to internally close a servo loop on a position command from the MAU. The brushless motor and ballscrew design gives low friction and low backlash for precision control while improving reliability over previous brushed motor and jackscrew designs. Independent position feedback is given to the MAU by an linear variable differential transformer (LVDT) sensor. The linear actuator includes a high integrity centering function to protect against runaway failure modes.

Rotary Actuator Description (Non-Honeywell)

The EPIC AFCS performs slower control movements by way of rotary actuators. The rotary actuators are installed in parallel with the pilots controls and have the same control travel authority as the pilot. They have a low-limit rate of control for malfunction-safety and can be overridden by pilot commands by way of a spring-clutch.

Three rotary actuators are required as part of the AFCS installation for aircraft featuring the 3-axis, 2-cue flight director configuration. There is one actuator for each aircraft axis of control: pitch, roll, and yaw. A fourth actuator is installed in the collective axis to give collective position and force feel. For aircraft featuring the 4-axis, 3-cue aircraft flight director configuration, the fourth rotary parallel actuator can be automatically driven by the autopilot system.

When used for cyclic and pedal control trimming, the rotary actuators are commanded to keep the average position of the output shaft of the linear series actuators centered (trimming). This is done to optimize the high performance response of the linear actuators to aircraft control commands.

When used for collective control, the rotary actuator is commanded using a position servo loop that is closed within the MAU flight guidance software. Position feedback is given to the MAU by a collective position sensor that is integrated with the rotary actuator.

Each rotary actuator includes an artificial feel mechanism for the pilot flight controls to simulate a control force feedback from a trimmed stick position. The pilot can choose to disable or enable this force feel system by way of one or more pilot accessible trim enable switches that remove or engage a clutch in the trim assembly. When the clutch is disengaged, the force feel system is disengaged and the rotary actuator drive is disengaged preventing autotrim, or collective, from driving the controls.

HIGH FREQUENCY (HF) RADIO (OPTION)

The HF-1050 radio system gives HF communications in the frequency range between 2.0 and 29.9999 MHz with 100 Hz resolution. The HF system gives 200 watts peak effective power (PEP) output power. It consists of three separate LRUs (antenna coupler, power amplifier, and receiver/exciter) and is interfaced in the AW139/AB139 installation with a shunt antenna.

Although not currently implemented on the AW139/AB139, the HF radio is capable of data communications. Audio from the HF radio system is connected to a transceiver port on the MRC to be digitized and distributed to the aircraft audio panels by way of the microphone and audio buses. Control of the HF radio is performed using the MCDU radio tuning function. The MCDU radio tuning function interfaces with the HF radio using an A429 interface connected to the CIO modules.

SENSORS

Air Data System (ADS)

A dual air data system is baseline on the AW139/AB139. The air data system consists of dual air data modules (ADM), dual outside air temperature (OAT) sensors, and software executing on processor modules in each MAU. The ADMs measure pitot and static pressure and internal temperature and transmit the raw data to the MAUs by way of the ARINC 429 interfaces. The OAT sensors interface to the MAUs. The raw data is processed within the MAUs to create various air data parameters such as corrected airspeed, altitude, vertical speed, and OAT. The processed data is available on the ASCB as well as one or more MAU ARINC 429 outputs.

Attitude and Heading Reference System (AHRS)

The baseline configuration of the AW139/AB139 calls for dual AHRS. The AHRS interfaces to PRIMUS EPIC using ARINC 429 interfaces.

Radio Altitude System

The basic system configuration includes a single radio altitude (RADALT) system. The SAR system configuration adds a second radalt system. Each RADALT system consists of a receiver/transmitter and two antennas. The RADALT interfaces to the MAUs by way of a DC analog signal and a 28 V dc/open valid signal.

Weather Radar System (Option)

A weather radar system is an option on the AW139/AB139. The PRIMUS EPIC system is designed to interface with the Honeywell PRIMUS 440/660/880 family or the PRIMUS 700/701 family of weather radars.

The PRIMUS 440/660/880 radar family is the newest Honeywell weather radar product and is optimized for weather detection. The different members of the family offer varying levels of functionality. The system consists of a nosecone-mounted RTA and cockpit-mounted controller, shown in Figure 2-15.

Figure 2-15
Weather Radar Controller

The PRIMUS 700/701 radars are optimized for SAR operations (short-range, ground mapping). The PRIMUS 701 gives the additional capability of beacon detection. The system consists of a nosecone-mounted antenna/pedestal, remote-mounted receiver/transmitter (R/T), and cockpit-mounted controller.

Both weather radars interface to the displays by way of the Honeywell standard picture bus and to the MAUs by way of an SCI control bus.

Lightning Sensor System (LSS) (Option)

The Honeywell lightning system is an option on the AW139/AB139. The system consists of an antenna and remote-mounted LRU. When a weather radar system is installed, a combined controller is used to control both the weather radar and lightning systems. When no weather radar system is installed, a dedicated LP-860 lightning controller is required. The lightning system interfaces to the MAUs by way of the ARINC 429 interfaces.

Traffic Alert and Collision Avoidance System (TCAS) (Option)

The Honeywell TCAS I system is an option on the AW139/AB139. This system consists of an antenna and remote mounted LRU. Control of the TCAS system is integrated by way of the MCDU pages used to control the transponder. The display of TCAS data is controlled using MFD menus. The TCAS traffic information is displayed as an overlay on the MFD map. Aural warnings from the TCAS are played through the audio system. The TCAS system interfaces with the transponder and the MAU CIO module by way of the ARINC 429 interfaces.

Enhanced Ground Proximity Warning System (EGPWS)/TAWS (Option)

The Honeywell Mark XXII EGPWS system is an option on the AW139/AB139. This system consists of a remote mounted LRU. Control of the EGPWS/TAWS system is integrated by way of the MCDU. Video from the EGPWS/TAWS is overlaid on the MFD map. Aural warnings from the EGPWS/TAWS are played by way of the audio system. The EGPWS system interfaces with the MAU CIO module by way of the ARINC 429 interfaces. Video is transmitted to the displays by way of a WX bus.

Digital Map (Option)

A stand alone digital map system is integrated with the PRIMUS EPIC. video from the digital map system is displayed on the MFD by way of the video module. The PRIMUS EPIC system contains navigation data such as FMS position on the ARINC 429 output for use by the digital map system.

SUBSYSTEM FUNCTIONS

Electronic Display System (EDS)

The EDS gives integrated display of primary flight, navigation, engine, aircraft systems, and caution/warning alerts. The EDS gives the following pilot controls:

- Display controller (Qty 2)
- Remote instrument controller (Qty 2)
- Cursor control device (Qty 2)
- Reversion switches
- Display dimming control.

Monitor/Warning System

A dual monitor/warning system is given. This system uses data obtained from ASCB, performs all necessary logic, and gives outputs by way of the ASCB to the displays to drive the crew alerting system (CAS) and various annunciators on the displays.

NOTE: The monitor/warning system is part of the vehicle management system (VMS) referred to in Agusta documentation.

Aural Warning System

A single aural warning system is given. The aural warning logic is performed by the monitor/warning system. The audio output circuitry is given by the control I/O module in MAU2. The system can give a combination of both tone and voice warnings.

Automatic Flight Control System (AFCS)

The AFCS is available in various configurations. The basic system includes a dual SAS/ATT autopilot and a dual 2-cue flight director. As an option, the basic system can add a dual 3-cue flight director. The SAR system has a dual 3-cue flight director with SAR modes.

The baseline SAS/ATT autopilot includes one autopilot controller, six linear actuators (two each pitch, roll, yaw), and four trim actuators. The 2-cue flight director system adds a guidance controller.

Navigation and Communication System

The navigation and communication subsystem gives the following functions:

- ICS (intercom system)
- VHF (very high frequency) communication
- VOR/ILS (VHF omni-directional radio range/instrument landing system) navigation
- DME (distance measuring equipment) navigation
- ADF (automatic direction finder) navigation
- Transponder
- TCAS (traffic alert and collision avoidance system)
- Radio control
- HF communication.

The modular radio cabinets are the core of the navigation and communication system. These cabinets house the VHF COM (VDR), VOR/ILS (VIDL), ADF, DME and transponder radios, together with the network interface module (NIM). The NIM gives processing functionality and interface with the ASCB databus. The NIM interfaces with the audio panels by way of the digital audio and microphone buses.

The radios are controlled using the MCDU and PFD radio tuning functions. The pilot intercom function and the control of audio from the radios are given by the AV-900 audio panels.

Flight Management System (FMS) (Option)

The FMS is based on the existing Honeywell FMS. This FMS is upgraded to give search patterns and mark on target (MOT) SAR capability. Modifications to the database have been made to give functionality more suited to the helicopter operations.

Global Positioning System (Option)

The global positioning system consists of a GPS module in MAU2 and an active GPS antenna. The global positioning system is part of the FMS option.

Maintenance System

The PRIMUS EPIC system contains an integrated maintenance system. The system consists of a central maintenance computer (CMC) module installed in one MAU, the LAN, and a remote terminal. The remote terminal is an off-the-shelf laptop computer with an Ethernet 10-Base-2 port and maintenance software. In flight, reported faults are gathered and stored by the CMC. Once on ground, maintenance activities can be performed after connecting the remote terminal to the LAN. The fault history is downloaded from the CMC to the remote terminal. The remote terminal can display stored faults or active faults to help the maintenance technician diagnose the problem. Alternatively, the cockpit displays can be used to display maintenance information.

Configuration Monitor System

The PRIMUS EPIC system contains generic hardware that can be loaded with software on the aircraft. The configuration of the system is complete after the generic hardware is installed in the aircraft and the software is loaded. Components of the EPIC system report their configuration identification electronically.

The configuration monitor system (CMS) monitors the electronic configuration identification. The CMS is responsible for verifying that the electronic software and hardware identifiers are correct for the aircraft configuration they are installed on, and are compatible with each other. In addition, the CMS is responsible for annunciating configuration failures and displaying configuration identifiers.

Integration of Non-Honeywell Systems

The PRIMUS EPIC system gives interfaces for the following non-Honeywell equipment:

- Flight data recorder (ARINC 573/717)
- Cockpit voice recorder (analog)
- Electronic engine controllers (RS-422a)
- Fuel computer(s) (ARINC 429)
- Health and usage monitor system (ARINC 429) (Option)
- Doppler sensor (ARINC 429) (Option)
- Passenger address system (analog)
- VHF NAV, ADF, DME radios (ARINC 429) (Option)
- Flight management system (ARINC 429) (Option).

In addition to the systems listed above, the avionics system gives additional ARINC 429 receivers for future growth. Non-Honeywell radios must use ARINC 429 labels defined in the ICD. A non-Honeywell FMS must conform to the A-429GAMA standard.

3. Electronic Display System (EDS)

INTRODUCTION

The EDS, shown in Figure 3-1 of the AW139/AB139 helicopter, is the primary point of interface between the pilot and the aircraft automation. It displays all the data required for aircraft control and navigation on three (four is an option) identical and interchangeable 8x10-inch, active matrix liquid crystal displays (AMLCD).

To enhance flight safety, the EDS is equipped with automatic display reversion capability. The automatic reversion is the primary mode, however, the pilot can use manual reversion mode as a back-up to turn OFF a failed display unit using the manual reversion switches. Turning the failed display unit OFF, with a reversion switch commands the remaining operational display unit to generate a composite format that displays data from the primary flight display (PFD) and the multifunction display (MFD).

The EDS function is broken down into three subfunctions, the graphics generation function (GGF), the monitor warning function (MWF), and the control abstraction layer function (CALF).

The GGF is responsible for rendering display objects on the DU-1080 display hardware. It processes data from the avionics standard communication bus (ASCB), the remote image bus (RIB), and other I/O sources to create the display commands that are processed by the DU-1080 hardware.

The monitor warning function supplies the logic for each of the crew alerts generated by the system. It manages presentation of aural and visual alerts. Visual alerts are given on the crew alerting system (CAS) display. The monitor warning function manages the scrolling and acknowledgment of these messages. Aural warnings are generated by the control I/O module hardware and transmitted to the audio panels. The monitor warning function prioritizes aural warnings that occur simultaneously and interleaves them where appropriate.

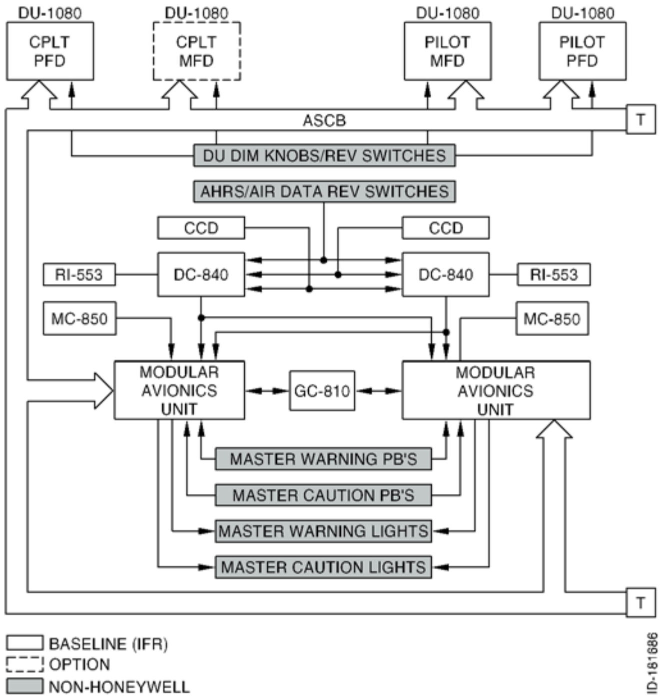


Figure 3-1
EDS Block Diagram

The controllers are used by the pilots to interface with the aircraft systems to control the display data and control system modes. The avionic system uses the following control panels:

- Display controller (DC)
- Cursor control device (CCD)
- Remote instrument controller (RIC)
- Multifunction control display unit (MCDU)
- Reversion control panel (RCP) (Agusta supplied)
- Dimming potentiometers (Agusta supplied)
- Master warning and master caution button annunciators (Agusta supplied).

In addition to the controllers directly associated with the EDS, other system controllers, such as the AFCS controllers, indirectly drive annunciators on the EDS. Controllers that indirectly drive annunciators on the EDS includes the following:

- Flight guidance controller (GC)
- Weather radar controller
- Lightning sensor controls
- Some of the autopilot control panel functions.

The EDS enables the pilot to employ automated flight functions, perform aerial navigation, monitor weather and terrain, monitor the health, and control the operation of the integrated avionics and automatic flight control systems of the helicopter.

The EDS is composed of the following primary components:

- AMLCD flat panel display units
  - — Basic configuration
    - Two PFDs
    - Two MFDs
  - — Display controller
  - — Cursor control device
  - — Remote instrument controller
  - — MCDU
  - — AFCS controllers
  - — Flight guidance controller
  - — Autopilot controller
  - — Reversion switches
  - — Dimming controls
  - — Master warning annunciator
  - — Master caution annunciator
  - — Flight director mode annunciators and command bars.

NOTE: Some versions of the AW139/AB139 helicopter do not include the flight director option. While remaining an option, provisions have been made to include flight director capability in follow-on variants of the helicopter. For this reason, ADI graphics incorporated in this text show flight director mode annunciators and command bars.

Display Color Usage

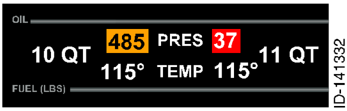
The colors used in PRIMUS EPIC displays follow the conventions listed in Table 3-1.

Table 3-1
Color Conventions

Color	Description
Red	Warning conditions Warning CAS messages Flight envelope and system limits Invalid primary instruments
Amber	Caution conditions Caution CAS messages Invalid data Miscompare annunciator
Magenta	FMS related data Active route/flight plan Flight guidance cue
Cyan	Advisory data Advisory CAS messages Crew selected data
Green	Engaged modes Current data NAVAID data ON status (synoptic displays)
White	Armed/standby modes Status data Status CAS messages Scales and associated figures Labels OFF status (synoptic displays).
Gray	Legends Symbols or units Boxes (limits for displaying information) Aircraft structures

Display Symbol Colors

Many of the graphic and digital displays change color when limits are reached or exceeded (usually from white to cyan, amber, or red). In some cases, the change is to **amber reverse video** or **red reverse video**. Reverse video is when the word or object displayed has black or white letters or objects and the area immediately surrounding the letters or object is the desired color.



Reverse video example: Note that the reverse video display of 485 uses **amber reverse video** with black letters while the 37 uses **red reverse video** with white letters.
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PRIMARY FLIGHT DISPLAY (PFD)

The following features, furnished to the flight crew by the PFD, as shown in Figure 3-2, are standard component functions of the AW139/AB139.

- Attitude display
- Barometric correction
- Slip/skid indicator
- Flight director command bars
- Collective cue display
- Flight director mode annunciators
- Autopilot mode annunciators
- Vertical deviation pointer and scale
- Radio altitude
- Decision height
- Marker beacons
- Altimeter scale and digital displays
- Airspeed scale, trend vector and digital displays
- Heading
- Drift bug
- Lateral deviation scale
- Bearing 1/2
- Distance

- Ground speed
- FMS messages
- DME identifiers
- Preview mode
- ITT, TQ and HG in the form of a power index
- Rotor speed (NR)
- Power turbine speed (Nf)
- Outside air temperature (OAT)
- Wind display
- Radio tuning data
- Source annunciators
- Source miscompare
- TCAS alerts
- TAWS alerts
- FMS map
- Hover display
- Terrain data from TAWS
- Weather data from WX
- Weather radar mode annunciators and alerts
- TAWS mode annunciators
- Cyclic position indication
- CAR A bugs and annunciations.

The flight information furnished by the PFD, shown in Figure 3-2, depends on the helicopter variant and system configuration as well as the equipment options selected by the pilot.

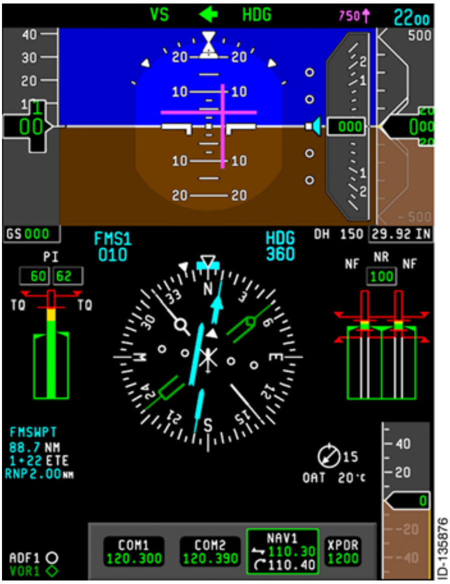


Figure 3-2
Typical PFD Display

MULTIFUNCTION DISPLAY (MFD)

The multifunction display, shown in Figure 3-3, shows the following types of information:

- Navigation Map and Plan modes
- Weather radar display and control
- TCAS (option) control and display
- TAWS (option) display
- Aircraft systems displays
- Maintenance
- Crew alerting system (CAS) messages
- Configuration management system (CMS).

Figure 3-3
MFD Window Layout

MFD ENGINE INDICATION AND CREW ALERTING SYSTEM (EICAS)

The engine indication and crew alerting system, shown in Figure 3-4, shows the following:

- Gas generator speed (NG)
- Inlet turbine temperature (ITT)
- Torque (TQ)
- Power turbine speed (Nf), and rotor speed (NR)
- Engine oil temperature and pressure
- Electrical parameters
- Main gearbox (MGB) temperature and pressure
- Fuel pressure (analogue scale), fuel quantity (total and each tank) and fuel flow
- Hydraulic pressure and temperature
- Crew alerting system (CAS) messages
- Intermediate gearbox (IGB) and tail gearbox (TGB)

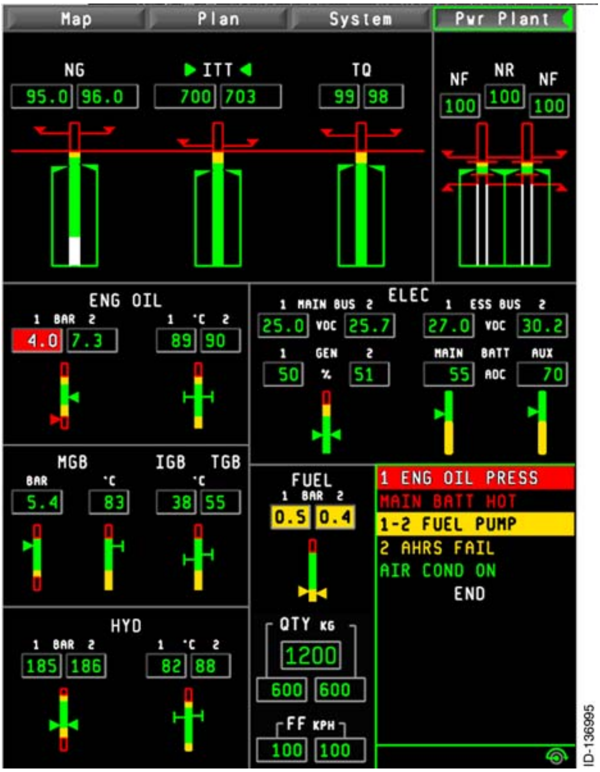


Figure 3-4
Typical EICAS Display

4. Controllers

INTRODUCTION

The controllers are used by the pilots to interface with the aircraft systems to control the display data and control system modes. The avionic system uses the following control panels:

- Display controller (DC)
- Cursor control device (CCD)
- Remote instrument controller (RIC)
- Autopilot controller
- Multifunction control display (MCDU)
- Audio panel
- Radar control panel
- Cabin audio controller
- Reversion controller.

Display Controller (DC)

The display controller, shown in Figure 4-1, gives the flight crew independent selection of short-range and long-range navigation sources, on-side/cross-side bearing sources, and the HSI format for display on the respective PFD. The display controller is directly connected to the cursor control device and the remote instrument controller.

Figure 4-1
Display Controller

The display controller buttons are described in the following paragraphs:

- **Circle Bearing (BRG) Button** - Pushing the circle bearing button

  permits selection of various sources, for example, VOR1 on the HSI display. ADF1, DF and FMS1 functions are integrated on this aircraft. They are displayed on the circle bearing pointer. The FMS and ADF appear in the selection sequence for both bearing pointers. The button sequence is as follows:

  OFF ☞ VOR1 ☞ ADF1 ☞ DF ☞ FMS1 ☞ OFF

- **BRG (Diamond Bearing) Button** – The diamond bearing button permits the selection of the VOR2 or ADF2 on the HSI display. The FMS2 is displayed on the diamond bearing pointer. When the single ADF is installed, it appears in the selection sequence for both bearing pointers. The button sequence is as follows:

ID-135972

OFF ☞ **VOR2** ☞ **ADF2** (option) ☞ **FMS2** ☞ **OFF**

NOTE: Both bearing pointers default to the OFF position at power-up.

- **NAV (Navigation) Button** – Pushing the **NAV** button toggles through the available short-range navigation sources displayed on the on-side PFD. Toggling the **NAV** button, changes the display formats in the following sequence:

ID-135973

☞ **On-side VOR/LOC** ☞ **Cross-side VOR/LOC** ☞ **On-side VOR/LOC**

The power-up default is set to the on-side VOR/LOC. Pushing the **NAV** button when the HOV (hover) flight director mode is active has no effect.

- **PRV (Preview) Button** – Pushing the **PRV** button shows the on-side or cross-side VOR/LOC on the display using a secondary course pointer when long-range NAV is the primary engaged navigation source. OFF is the default setting. Toggling the **PRV** button changes the display formats in the following sequence:

ID-135974

OFF ☞ **Preview mode ON (on-side VOR/LOC)** ☞ **Preview mode ON (cross-side VOR/LOC)** ☞ **Preview mode OFF**

The **PRV** button has no effect when the FMS is not selected as the current NAV source. The PRV button has no effect when the hover flight director mode is active.

When approach (APP) or backcourse (BC) is selected on the flight director, the previewed navigation source becomes the current NAV source. This occurs when the captured criteria is met for the short-range navigation source.

- **LNAV (Lateral Navigation) Button** – The LNAV lateral mode

intercepts, captures, and tracks the active leg of the FMS flight plan displayed on the on-side PFD. Continuing to push the **LNAV** button toggles through the available long-range navigation sources. Pushing the **LNAV** button results in the following sequence selections when multiple FMS functions are installed.

  ☞ On-side FMS ☞ Cross-side FMS ☞ On-side FMS

  The hover HSI format is automatically displayed when the HOV or MOT flight director modes are selected. It is necessary to have FMS selected as the navigation source in order to display the hover format of the HSI. Automatically displaying the hover format when HOV or MOT is selected implies that the FMS is automatically selected as the navigation source when HOV or MOT modes are engaged.

  When the HOV or MOT flight director modes are selected and FMS1 and FMS2 are not currently selected as the primary navigation source on the HSI, the primary navigation source automatically switches to the on-side FMS. When there is a loss of both display controllers, then the primary navigation source is automatically switched to the on-side FMS.

HORIZONTAL SITUATION INDICATOR (HSI) DISPLAY MODE CONTROLS

There are three buttons that operate together to control the format of the HSI. These buttons are labeled **HSI**, **MAP**, and **WX/TERR**. There are a total of nine HSI display formats that can be selected. These display formats are:

1. **FULL**: Displays a conventional HSI with a full 360° compass rose.

2. **ARC**: Displays an expanded arc of the compass rose extending to ±45°.

3. **HOV**: Displays the HSI HOV mode with a velocity vector.

4. **HOV + 360° MAP**: Displays HOV mode with velocity vector and FMS map overlay.

5. **ARC + MAP**: Displays the arc mode with an FMS map overlay.

6. **ARC + WX**: Displays the arc format with a WX overlay.

7. **ARC + TERR**: Displays the arc format with EGPWS terrain overlay.

8. **ARC + MAP + WX**: Displays the arc mode with FMS map and WX overlays.

9. **ARC + MAP + TERR**: Displays the arc format with FMS map and EGPWS terrain overlays.

- **Horizontal Situation Indicator (HSI) Button** - The **HSI** button

ID-135976

permits the pilot to select between a full compass (360°) display, hover, or an arc (45° centered on the aircraft nose) compass display. The power-up sequence is set to full compass. When the FMS is the selected primary navigation source, the button sequence is:

  Full Compass ☞ Arc Compass ☞ HOV ☞Full Compass

  When VOR or ILS is selected as the primary navigation source, or when either have been selected as the preview navigation source, pushing the **HSI** button toggles between the full and arc formats of the HSI. Access to the HOV format of the HSI is possible when no short-range navigation source is selected or previewed.

  The hover display format on the HSI is automatically selected when the HOV or MOT flight director modes are engaged. When the HOV flight director mode is active, pushing the HSI button has no effect so that it is not possible to select any other HSI display format.

  Selection of the MOT mode results in automatic selection of the hover format on the HSI. The pilot can toggle back to the FULL or arc HSI modes when the MOT flight director mode is active.

- **MAP Display Control Button** - Pushing the **MAP** button toggles

ID-135977

ON and OFF the FMS map overlay on the HSI. When the full compass HSI format is displayed, this button automatically selects the arc compass mode and enables display of the FMS map on the HSI on the PFD. The FMS display is defaulted to OFF in the power-up position. The button sequence is:

  Full or Arc: Full or Arc ☞ Arc + Map ☞ Arc

  HOV: HOV + 360 ☞ Map HOV ☞ HOV + 360 Map

  When the hover format of the HSI is selected, the 360-degree map display is enabled. When the hover format is displayed, pushing the **MAP** button alternately disables and enables display of the 360 degree map.

- **WX/TERR (Weather Radar/Terrain) Control Button** – Display of

weather and TAWS (EGPWS) terrain data is mutually exclusive. Pushing the **WX/TERR** button permits selection of weather radar or terrain data overlay for display on the HSI. When the full or hover formats are selected on the HSI and the HOV mode is not active, pushing this button automatically selects the arc format of the HSI. The button sequence is as follows:

  WX/TERR DATA OFF ☞ ARC + WX ☞ ARC + TERR

  WX/TAWS DATA is defaulted to OFF in the power-up position.

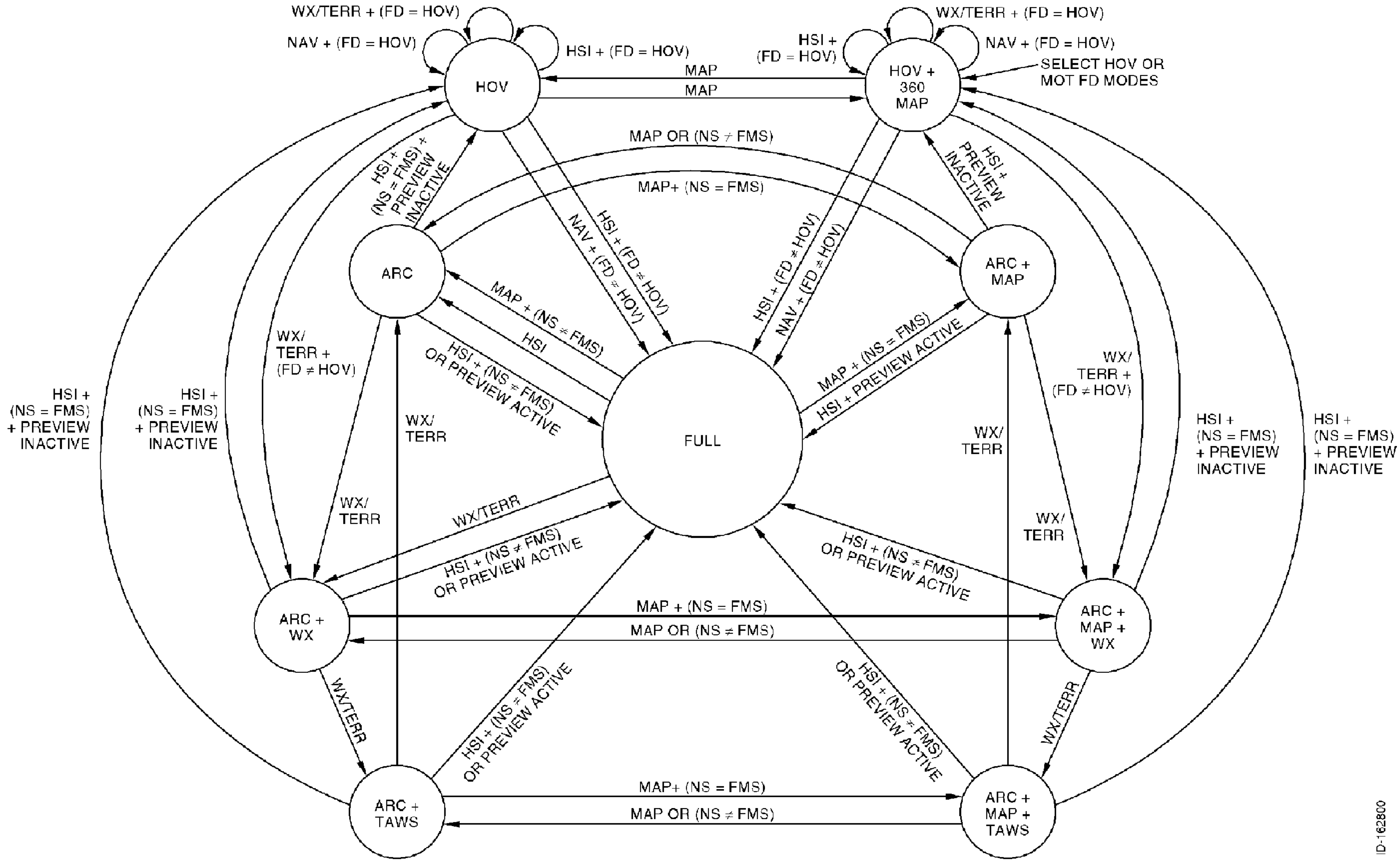
  When WX or TAWS (EGPWS) is not installed, selection of the corresponding item is removed from the sequence of the **WX/TERR** button on the display controller. NO WX/TAWS INSTALL is displayed for five seconds when the **WX/TERR** button is pushed when weather radar or TAWS is not installed in the aircraft.

  The **WX/TERR** button has no effect when the HOV mode is active.

HSI DISPLAY FORMAT STATE TRANSITIONS

The **HSI**, **MAP**, and **WX/TERR** buttons on the display controller operate in conjunction with the selected navigation source and flight director mode to control selection of the various HSI display modes in accordance with state transition diagram, as shown in Figure 4-2.

For example, when the hover display is active and the HOV mode is not active, pushing the **NAV** button on the display controller returns the HSI to the full compass format with the on-side VOR or LOC as the selected navigation source.

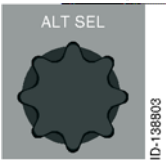


NOTES:

1. NS – Navigation source
2. FD – Flight director mode
3. The above state transition diagram assumes that both the weather radar and TAWS (EGPWS) are installed. When one is not installed, the corresponding state does not exist.

Figure 4-2
HSI Display Format State Transition Diagram

- **ALT SEL (Altitude Select) Knob**– The **ALT SEL** knob controls the setting of the barometric altitude reference on the pilot and copilot PFD altitude tapes. The selected altitude is used for the altitude preselect and altitude alert functions. Rotating the knob clockwise increases the preselect value and counterclockwise rotation decreases the value. The selected altitude drives the altitude intercept function as well as the altitude alert function when in a flight director mode.



- **BARO (Barometric) Pressure Control Knob** – Turning the **BARO** knob changes the corrected barometric pressure setting on the PFD for the on-side air data computer (ADC).

  The MAU produces the **BARO** knob data independent of the cross-side MAU. The barometric correction is synchronized between the two air data functions.

CURSOR CONTROL DEVICE (CCD)

The CCD, shown in Figure 4-3, is the primary means of control for the pilot to manipulate data on the display units. It consists of a control panel with two display select buttons, the set knob with dual concentric knobs, a 4-way joystick, and an **ENTER** button. The joystick is used to move the cursor through the MFD and operate the MFD designator and radio tuning on the PFD.

Figure 4-3
Cursor Control Device

- **Display Select (Left and Right Buttons)** - The display select

buttons correspond to the respective crewmembers display. In helicopters configured with three display units, either pilot can control the center MFD with their own CCD. The last pilot to select control of the MFD has control of the MFD.

In helicopters configured with four display units, the buttons work as described in the following paragraphs.

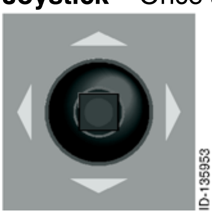
Pushing the right button (**RH**) on the pilot-side CCD gives the pilot control of the system and moves the cursor to the PFD.

When the CCD cursor is active, the pilot-side PFD is used to control PFD selections. Some of these selections include radio frequency and NAV frequency changes.

Pushing the left button (**LH**) on the pilot-side CCD positions the CCD cursor from the PFD to the MFD.

When the CCD is active in the MFD, it is used to select from the menus and controlling submenu functions.

- **Joystick** - Once a display unit has been selected with the display



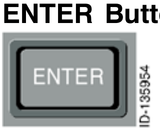
select buttons, the joystick is used to position the cursor within the selected display unit.

Moving the joystick to the left-of-center or right-of-center moves the cursor left or right, respectively, in the the active display page.

Moving the joystick forward or aft of center moves the cursor up and down, respectively, on the active display page. The cursor movement (left, right, up, and down) on the display page permits the pilot to select and control functions on the MFD and PFD.

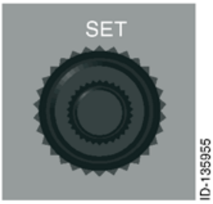
The joystick moves the cursor through the MFD menu selections and operates the MFD designator. It also is used for the radio tuning function.

- **ENTER Button** - Once a submenu function has been selected



using the joystick to position the cursor, pushing the **ENTER** button activates or deactivates the selected submenu function.

- **Set Knob** – The dual concentric rotary knob on the CCD consists of two knobs comprised of a large bottom knob with a smaller knob on top. The dual concentric rotary set knobs are used to control functions highlighted by the cursor. Symbols are displayed to indicate which function each knob is controlling.



Examples of functions that can be controlled using the set knob are:

- Scrolling of CAS messages
- Controlling PFD or MFD MAP range
- Waypoint scrolling when designator mode is active
- Tuning radios
- Setting system clock.

REMOTE INSTRUMENT CONTROLLER (RIC)

The RIC, shown in Figure 4-4, is used to set the course, decision height, and headings. The control panel has three control knobs with associated buttons that are described in the following paragraphs.

Figure 4-4
Remote Instrument Controller

- **COURSE Select Knob** – The course select knob selects the desired course during short-range NAV or NAV preview on the on-side HSI. Pushing the **PUSH DIR** button synchronizes the on-side selected course to the on-side VOR bearing, pointing the course pointer to the on-side VOR bearing.

- **HEADING Select Knob** – The heading select knob controls the heading select bug for both HSI. When the map page is selected on the MFD, the heading bug is displayed. Pushing the **PUSH SYNC** button synchronizes the selected heading bug to present heading of the coupled attitude and heading reference system (AHRS) or to the heading of the on-side AHRS when the flight director is not coupled. The heading select bug on the two displays are synchronized to the same heading value.

- **DH (Decision Height) Knob** – The decision height (**DH**) knob selects the value of the decision height which is displayed on the on-side PFD. Pushing the **PUSH TEST** button executes the test function for the radio altitude system.

The radio altitude test can only be activated by the copilot MAU by pushing the **PUSH TEST** button on either side RIC.

GUIDANCE CONTROLLER

The guidance controller, shown in Figure 4-5, is installed in the center console. It is used to select the coupled flight director and to control the AFCS flight director functions.

Figure 4-5
Guidance Controller for the 4-Axis Configuration

The flight director mode-select buttons on the guidance controller engage and disengage the different flight director modes. A green annunciator (▌) lights on each button and annunciators on the PFD indicate which flight director modes are engaged (either armed or captured). The mode-select buttons are back-lit for ease of identification in low ambient light level conditions.

The guidance controller has two identical independent channels. Each one communicates with a separate MAU assuring channel redundancy.

NOTE: A detailed description of the guidance controller functions are described in Section 8, Automatic Flight Control System.

AUTOPILOT CONTROLLER

The autopilot controller, shown in Figure 4-6, is used to turn the autopilot functions ON/OFF, select AP modes, and perform the system preflight test.

Figure 4-6
Autopilot Controller

NOTE: A detailed description of the autopilot controller functions are described in Section 8, Automatic Flight Control System.

MULTIFUNCTION CONTROL DISPLAY UNIT (MCDU)

The MCDU, shown in Figure 4-7, combines a keyboard and an associated display. The MCDU permits the pilot to control several of the helicopter functions. Some of these functions include the FMS (refer to Honeywell publication A28-1146-181, FMS for the Agusta AW139/AB139 helicopter) and radio tuning functions.

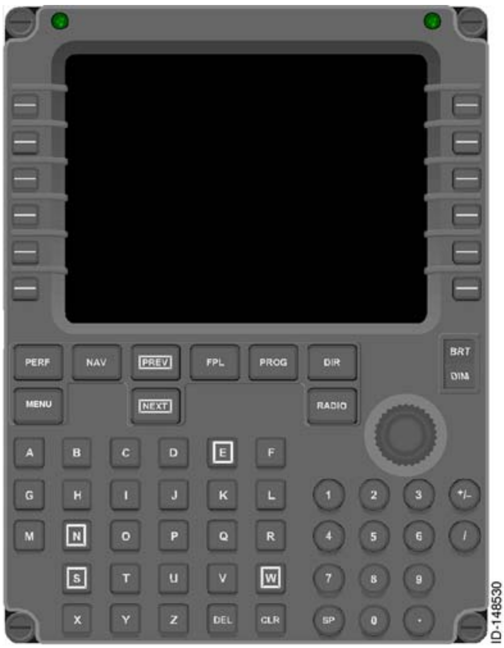


Figure 4-7
Multifunction Control Display Unit

NOTE: A complete description of the MCDU radio tuning function are given in Section 10, Radio System.

RADIO AND AUDIO SYSTEMS

Audio Panel

The audio panel, shown in Figure 4-8, is the central point for controlling the aircraft radio and audio systems. It converts digital audio signals from communication and navigation radios into analog signals that are audible in headphones and speakers. The audio panel converts analog signals from microphones to digital signals for transmission. The audio panel controls the intercom system (ICS) in the cockpit and cabin along with the external intercom access used by maintenance personnel. Aural warning signals are amplified through the audio panel to the cockpit speakers or headphones. In addition, the audio panel supports non-integrated radios such as high frequency communications (HF COMM) radios and satellite communications radios (SATCOM), when installed.

Figure 4-8
Audio Panel

NOTE: The functions of the audio panel are described in detail in Section 10, Radio System.

Radar Control Panel

The PRIMUS EPIC 660 and P700/701 Digital Weather Radar Systems are a lightweight, X-band digital radar with alphanumerics designed for weather detection (WX) and ground mapping (GMAP). The radar control panel, shown in Figure 4-9, is utilized to detect storms along the flight path, and give the pilot a visual color indication of rainfall intensity indicating where there may be turbulence. After proper evaluation, the pilot can chart a course to avoid storm areas.

Figure 4-9
Radar Control Panel

NOTE: The functions of the WX radar and its controller are described in detail in the Section 16, PRIMUS EPIC 660/700/701 Digital Weather Radar System.

Cabin Audio Controller

The cabin audio controller, shown in Figure 4-10, is mounted in the overhead (ceiling) of the cabin.The standard helicopter headset jack (connector) found in the left side of the control head connects the user to the audio system.

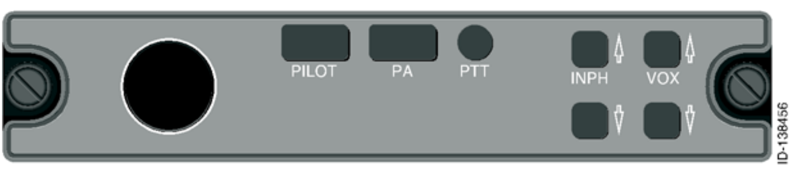


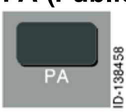
Figure 4-10
Cabin Audio Controller

The buttons on the cabin audio controller head are used to control specific functions of the audio system. Pushing the buttons activates the function. Pushing the button again deactivates the function. The cabin audio controller buttons and their functions are listed in the following paragraphs:

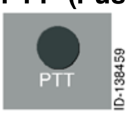
- **PILOT** - Pushing the **PILOT** button activates the cabin intercom system (ICS). It is used by crew or passengers as a discrete means of contacting the pilot by flashing the CAB button on the pilot-side audio panel.

The **CAB** button on the pilot-side audio panel flashes until it is selected by the pilot or deselected by the cabin operator.

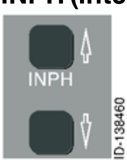
- **PA (Public Address) System** - Pushing the **PA** button connects cabin crew or passengers to the public address system.



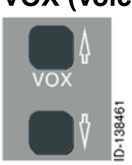
- **PTT (Push-To-Talk)** - The **PTT** button is pushed when the crewmember wants to speak over the public address (PA) system.



- **INPH (Interphone) System** - The **INPH** buttons are used to control headset audio volume. Pushing the button beside the up arrow ( ) increases headset volume. The down arrow ( ) decreases the volume.



- **VOX (Voice Activated) Squelch System** - The **VOX** buttons are used to control VOX volume for the headset volume control. Pushing the button beside the up arrow ( ) increases headset volume. The down arrow ( ) decreases the volume.



REVERSION CONTROLLER

The reversion controller (non-Honeywell controller), shown in Figure 4-11, is used for reversion control of the displays, air data system, and AHRS.

For the displays, in the manual display reversion mode, the pilot can combine essential flight data from a failed display unit onto a functioning display and continue the flight. Reversion conditions exist when either an MFD or PFD is inoperative. Operational details are described in Section 7, Display Reversion.

Figure 4-11
Reversion Controller

5. Primary Flight Display (PFD)

INTRODUCTION

The flight information furnished by the PFD depends on the helicopter variant and system configuration as well as the equipment options selected by the pilot.

The following features are standard component functions of the AW139/AB139.

- Altimeter scale and digital displays
- Barometric correction
- Slip/skid indicator
- Flight director command bars
- Flight director mode annunciators
- Autopilot mode annunciators
- Vertical deviation pointer and scale
- Radio altitude
- Decision height
- Marker beacons
- Airspeed scale, trend vector, and digital displays
- Vertical speed scale, trend vector, and digital display
- Heading
- Drift bug
- Lateral deviation scale
- Bearing 1/2
- Distance
- Ground speed
- FMS messages
- DME identifiers
- Preview mode
- ITT, TQ and NG in the form of a power index
- Rotor speed (NR)

- Power turbine speed (Nf)
- Outside air temperature (OAT)
- Wind display
- Radio tuning data
- Source annunciators
- Source miscompare
- TCAS alerts
- TAWS alerts
- Attitude display
- Collective cue display
- FMS map
- Terrain data from TAWS
- Weather data from WX
- Weather radar mode annunciators and alerts
- TAWS mode annunciators
- Cyclic position indication

A dedicated dimming knob controls the light intensity of the PFD. The dimming controls are 0–10k ohm, one–quarter watt potentiometers. The outputs of the dimming knobs go directly to the display unit (DU).

When the displays are set for full dim, the dimming floor inhibits the display from going so the dark that it becomes unreadable in nighttime ambient light conditions.

When the dimming controls fail, the displays are set at 85% of the full bright intensity.

PFD LAYOUT

The PFD shows information required to develop and maintain continual situational awareness throughout all flight regimes. This situational awareness enables the flight crew to perform safe aerial flight and navigation.

The PFD, as shown in Figure 5-1, shows the position of the primary segments of the PFD. Each segment shows items of information unique to its function in standardized positions and formats. These items of information are described in the following sections:

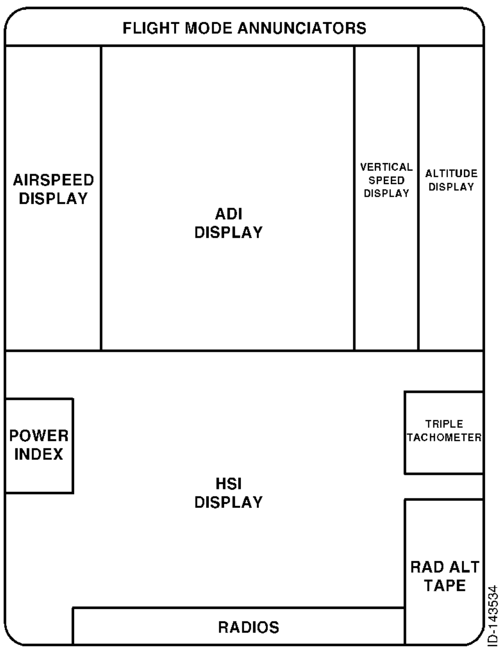


Figure 5-1
PFD Segment Window Diagram

When auto or manual reversion occurs, as shown in Figure 5-2, a composite display is generated on the PFD along with a CAS window.

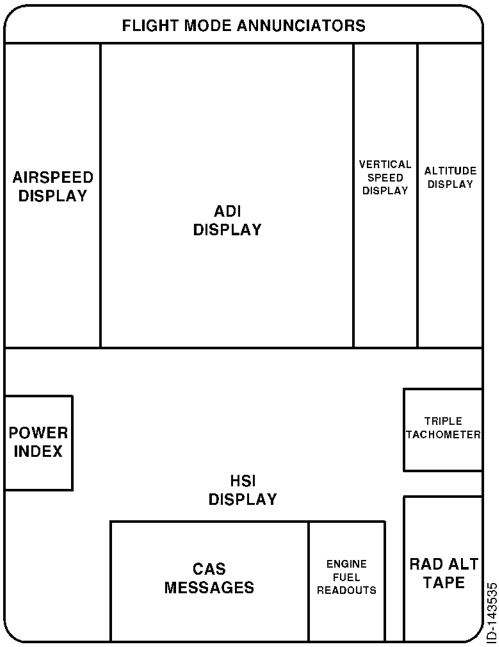


Figure 5-2
PFD Segment Window Diagram
With CAS Window Position

The PFD with arc compass, as shown in Figure 5-3, is displayed.

Figure 5-3
Primary Flight Display - Arc Compass Mode (Typical)

The PFD, as shown in Figure 5-4, shows the low altitude alert in the brown **shading** on the ALT tape and RADALT tape, on the top and bottom right corner of the PFD.

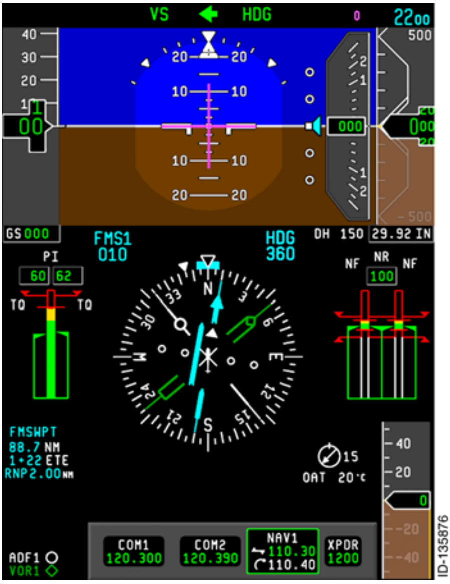


Figure 5-4
Primary Flight Display - On the Ground With Flight Director and Low Altitude Awareness Indications

The PFD, as shown in Figure 5-5, shows the miscompare boxes and their positions.

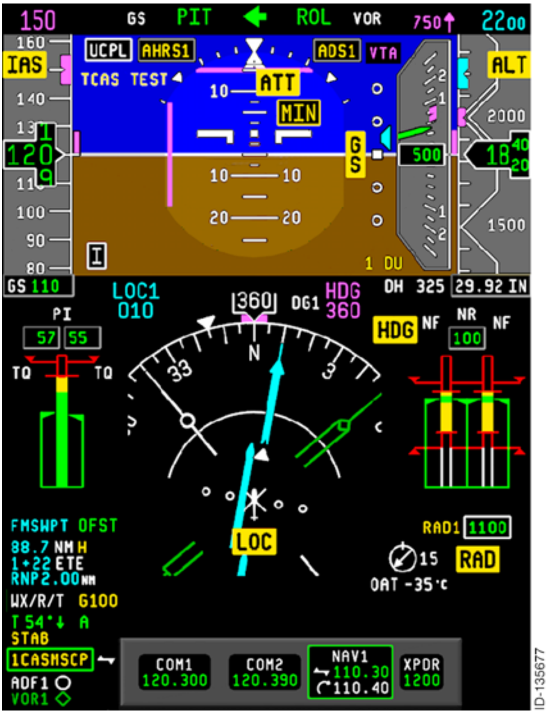
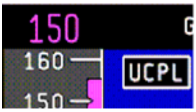


Figure 5-5
Primary Flight Display - Arc Compass With Miscompare Annunciators

AUTOPILOT (AP) ANNUNCIATORS

AP mode annunciators are displayed on the PFD when they have been engaged. The SAS, UCPL, and CLTV annunciators occupy the same space on the PFD display. The function and position of each are described in the following paragraphs:

- **UCPL (Uncoupled) Annunciator** – When the autopilot is coupled from an active flight director mode, pushing the **CPL** button on the AP controller shows the **UCPL** annunciator on the PFD. The **UCPL** annunciator shows in the upper left corner of the ADI between the attitude source annunciator and the airspeed tape. The **SAS**, **UCPL**, and **CLTV** annunciators are mutually exclusive and occupy the same space on the PFD display. When enabled, the **UCPL** annunciator flashes reverse video for the first six seconds before becoming steady.



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- **SAS (Stability Augmentation System) Annunciator** – When **SAS** is engaged, **SAS** annunciates in the upper left corner of the ADI between the attitude source annunciator and the airspeed tape.

- **CLTV (Collective) Annunciator** – For a 3-cue flight director, a **CLTV** annunciator is present on the PFD in the upper left corner of the ADI when either autopilot indicates that the collective axis is uncoupled.

FLIGHT DIRECTOR MODE ANNUNCIATORS

Flight director mode is displayed in the modes field on the PFD. There are five flight director mode annunciator fields that consist of armed lateral, active lateral, active vertical (pitch), armed vertical, and active vertical (collective).

NOTE: The flight director is an option for the AW139/AB139.

- **Flight Director Couple Arrow** – The PFD source select arrow is located in the center of the **black bar** at the top of the ADI display on each PFD. The source select arrow points towards the PFD that is supplying navigation and mode select data by both flight directors.

The PFD source select arrow is green when all associated flight director sensors are valid. The PFD source select arrow is amber when an associated flight director sensor is invalid (such as, the flight director must use cross-side data)

The **FD FAIL** annunciator replaces the flight director arrow when flight director information becomes unreliable. When the flight director is not installed, the annunciator is blank.

- **Lateral and Vertical Flight Director Modes** – Lateral modes, as shown in Figure 5-6, are displayed to the right of the flight director couple arrow and vertical modes to the left. (Figure 5-6 is not a valid display. It shows the location of armed and captured annunciators). One lateral and one vertical mode is permitted. The flight director mode annunciators are displayed on each PFD when active. **Captured** or **engaged** modes are displayed in green, and **armed** modes are displayed in white. When a mode switches from armed to captured, it changes from white in the far left or right box to green in the inner right or left box. It flashes from **green** to **green** for six seconds and remains **green** when tracking.

Figure 5-6
Lateral and Vertical Flight Director Modes

The armed and captured annunciators are listed in Table 5-1 and Table 5-2.

Table 5-1
Lateral Mode Annunciators

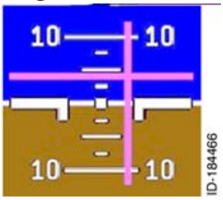
Armed	Captured
VOR	VOR
VAPP	VAPP
LOC	LOC
BC	BC
LNAV	LNAV
	HDG
	HOV
	OS
	MOT
	TD2
	TU

Table 5-2
Vertical Mode Annunciators

Armed	Captured
GS	ALT
DCL	GS
VGP-DCL	VS
VGP	GA
GS-DCL	IAS
	TD1
	ALVL
	DCL
	HOV
	TD2
	TU
	MOT

When the aircraft personality module (APM) and the flight director are used, the pilot can utilize 3-cue functionality for collective modes. When collective limiting is indicated by the flight director, captured vertical pitch and captured vertical collective flight director mode annunciators are displayed in amber. In addition to Table 5-2, captured vertical collective mode includes ALTA, RHT, and VGP.

- **Flight Director Command Bars** – Flight director command bars



are vertical and horizontal magenta lines displayed on the attitude director indicator (ADI) when a flight director mode is engaged. The command bars give a visual representation of the guidance commands from the flight director.

When a flight director mode is engaged, and remains uncoupled from the AP, it permits the pilot to manually fly the aircraft using the directional cues presented by the command bars. To follow the command bars, the pilot manually flies the aircraft to where the command bars intersect on the ADI. In the previous illustration, the aircraft is below and to the left of the desired course and altitude. The pilot should execute a climbing, right-hand turn to place the aircraft on course and at the designated altitude.

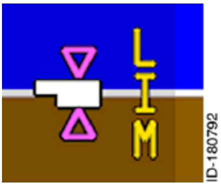
When a flight director mode is engaged and coupled to the AP, the AP flies the aircraft in accordance with guidance commands from the flight director. The command bars cue the pilot to the direction the aircraft is commanded to fly.

Under normal conditions, each PFD shows command bars and associated mode annunciators from its on-side flight director. Movement of the command bars match the attitude pitch tape. Flight director failure removes the command bars.

Command bars are limited to the following:

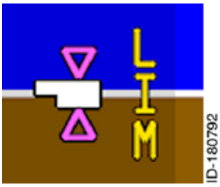
- ±20° pitch command
- ±20° roll command.

COLLECTIVE CUE AND REFERENCE MARKERS



Under normal conditions, the collective cue is displayed on each PFD from the on-side flight director.

For a 3-cue flight director, the collective cue and collective reference markers are displayed to the right of the airspeed tape when a collective flight director mode is chosen. The collective reference markers are set as hollow triangles pointing towards each other. The space between the triangles are equal to the width of the collective cue.



A **LIM** annunciator is displayed to the right of the collective cue display when the flight director indicates that the collective limiting is active on pitch or collective command. However, a loss of a valid flight director does not display the collective cue, reference markers and the **LIM** annunciator.

For a 3-cue flight director, a **5 MIN** annunciation is displayed between the collective cue and the airspeed tape.

Collective cue display limitations are as follows:

- The collective cue is placed above the TAWS annunciators when the flight director collective bar command indicates +100%.
- The collective cue is placed below the TCAS annunciators when the flight director collective bar command indicates -100%.
- When the flight director collective bar command indicates 0%, the collective cue moves linearly between the TAWS and the TCAS annunciators. In the center position, the collective bar is aligned with the aircraft symbol.

A loss of a valid flight director (AFCS) removes the collective cue, the reference markers, the **5 MIN** and **LIM** annunciators.

ATTITUDE DIRECTION INDICATOR (ADI)

The ADI instruments, as shown in Figures 5-7, 5-8, and 5-9, are displayed on the PFD in a digital format arranged in a modified T configuration. Figure 5-7 is typical of a helicopter leaving straight and level flight. The altimeter to the right of the ADI reads **1830** feet (ft), the airspeed tape to the left of the ADI reads **120** knots (kts), and the vertical speed indicator shows the beginning of a **500** fpm climb.

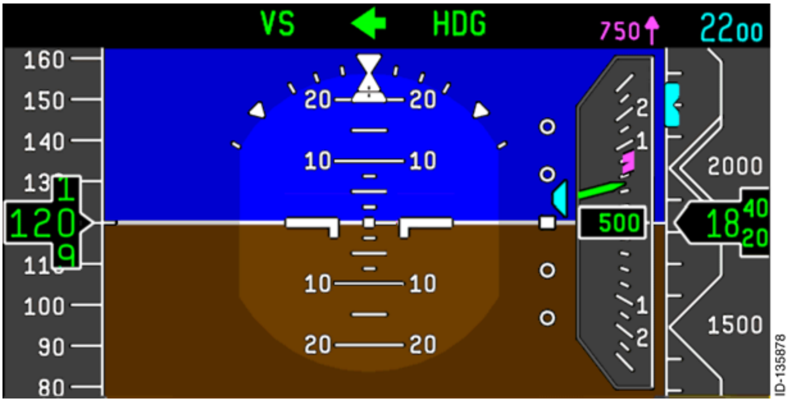


Figure 5-7
PFD Attitude Direction Indicator (ADI) Segment (Typical)

The ADI instruments, as shown in Figure 5-8, display an aircraft on the ground with the flight director armed. The magenta legends and the low altitude awareness displays indicate the helicopter is on the ground.

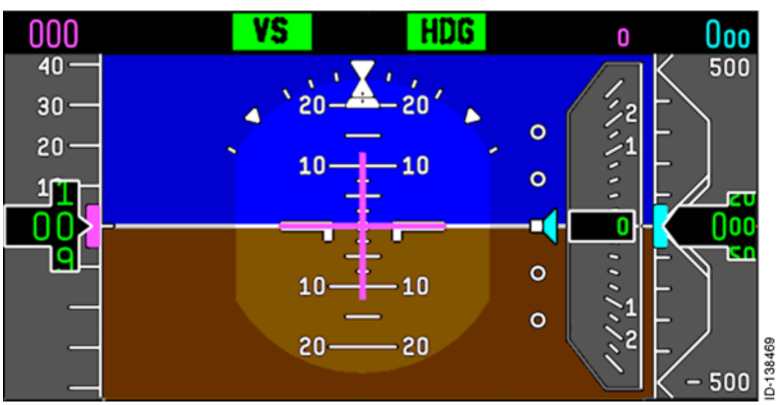


Figure 5-8
Attitude Segment (Typical) on the Ground With Flight Director Armed

Miscompare indicators and other annunciators, as shown in Figure 5-9, are displayed on the ADI when necessary.

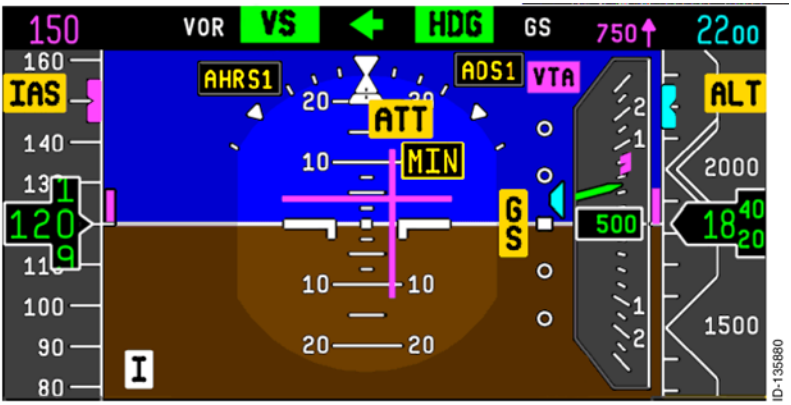


Figure 5-9
Attitude Segment With Miscompares and Associated Annunciators

Attitude Direction Indicator (ADI) Segment

The center of the PFD, as shown in Figure 5-10, is the ADI. The ADI is limited to displaying pitch attitudes between ±90°, but it can indicate roll attitudes through ±180°.

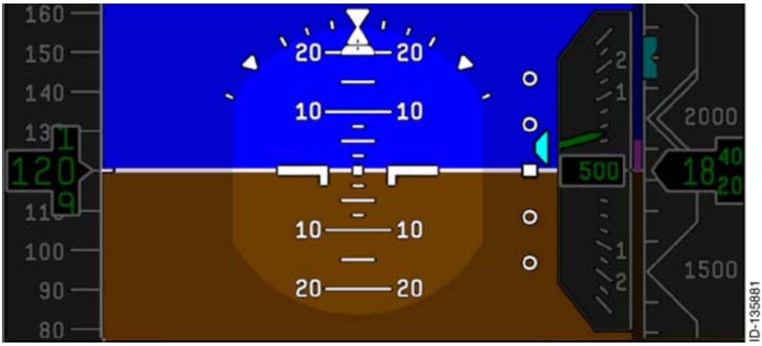


Figure 5-10
Attitude Direction Indicator (ADI) (Typical)

- **Artificial Horizon** – The natural horizon is depicted artificially on the attitude display of the PFD as a white, horizontal line that joins the bottom edge of the cyan field with the top edge of the brown field. The cyan field represents the sky and the brown field represents the surface of the earth.

  Pitching the aircraft in a nose-up position increases the area of the cyan field, queuing the pilot to a nose-high attitude. The rate the cyan field increases in area is proportional to the rate of pitch change.

  Pitching the aircraft in a nose-down position increases the area of the brown field, queuing the pilot to a nose-low attitude. The rate the brown field increases in area is proportional to the rate of pitch change.

  For pitch angles greater than 25°, a portion of the sky or ground shading remains visible to show the direction of the sky or ground.

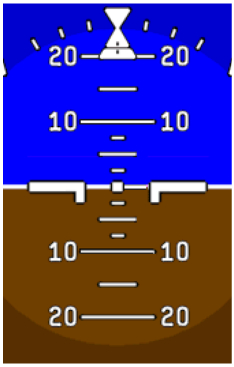
- **Aircraft Reference Symbol** – The aircraft reference symbol is

  depicted in white and is in the center of the attitude sphere. The position of the aircraft reference symbol in relation to the attitude pitch tape indicates the number of degrees the aircraft is nose-high or nose-low.

  The aircraft reference symbol indicates bank angle changes. The reference symbol indicates the magnitude of change in degrees and the rate at which bank angle is changing.

- **Attitude Pitch Tape** – The pitch tape is displayed in the center of the ADI with white **linear markings** showing ±20° when the aircraft is in straight and level flight. The linear markings move up or down behind the aircraft symbol as the pitch attitude changes.



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The linear markings are placed at 2.5° increments between 0° and ±10° and at 5° increments up to 30°. The 2.5° , 5° and 10° increments are distinguished from each other by making each marking longer. The pitch tape is labeled with numbers on both sides of the tick marks through +30°/–20°/ and in the middle of the tick mark for greater than +30°/–20°.

The pitch tape scale is indexed with the indices listed in Table 5–3.

Table 5–3
Pitch Tape Scale Indices

UP	Down
10°	10°
20°	20°
30°	30°
40°	45°
60°	60°
90°	90°

- **Pitch Attitude Warning Indicator** – When the system determines that an excessive pitch angle exists, pitch attitude warning indicators are displayed on the ADI.

ID-135884

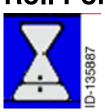
Hollow, red, pitch attitude **chevrons** come into view on the pitch tape when the pitch angle arrives at –9° nose–down or +21° nose–up. Two pitch–down chevrons increase in size on the display as the nose–up angle increases.

Three pitch up chevrons increase in size as the nose-down angle increases. The direction of the chevrons indicate the appropriate attitude correction.

- **Roll Scale** – A linear roll scale is visible at the top of the ADI with graduations marking the ±10°, ±20°, ±30°, and ±60° angle of bank positions.

An inverted triangle marks 0° and the 45° angle of bank positions.

- **Roll Pointer and Slip/Skid Indicator** – Bank angle and roll rates are identified on the ADI by a white segmented **triangle**. Subsequently, the triangle is called the roll pointer. When bank is introduced, the roll pointer displaces left or right of the 0° point of the linear roll scale. Displacing left indicates the aircraft has entered a right bank. Displacing right indicates the aircraft has entered a left bank. The direction and angle of bank is shown by the position of the roll pointer in relation to the linear roll scale. When the roll pointer is positioned midway between the second and third marking left of the 0° position, the aircraft is in a 25° angle of bank.



The bottom segment of the roll pointer is the slip/skid indicator. It identifies a slip or skid by displacing left or right of the top segment of the roll pointer.

As long as the aircraft is flown in coordinated flight, the roll pointer and slip/skid indicator form a white **triangle**. When a slip or skid is induced, the **slip/skid** indicator moves sideways and turns amber, as in the example at left.

When the aircraft rate of turn is too great for the existing angle of bank, the aircraft is in a skid. The slip/skid indicator displaces outside the roll pointer away from the turn direction.

When the aircraft rate of turn is too slow for the existing angle of bank, the aircraft is in a slip. The slip/skid indicator displaces inside the roll pointer in the direction of the turn.

The **skid pointer** displaces laterally and turns amber when lateral acceleration exceeds 0.1 g. In analog terms, when the **skid pointer** displaces laterally and turns amber, the aircraft yaw is one ball out of trim.

When lateral acceleration, pitch or roll information from the AHRS becomes unreliable, the slip/skid indicator is removed from the PFD and is replaced with an amber **X**.

AIR DATA SOURCE (ADS) ANNUNCIATOR

The ADS annunciator is displayed at the top of the ADI at the right of the zero index marker on the roll scale to confirm which ADS is currently in use.

The ADS reversion switch on the reversion control panel, shown in Figure 5-11, is used to select the ADS source for both pilot and copilot displays.

Figure 5-11
Reversion Control Panel

- **Air Data Source Annunciators** - When displayed sources for the pilot and copilot are the same, **ADS1** or **ADS2** annunciates on both PFDs.

The ADS annunciator is not displayed when the displayed sources of the pilot and copilot are from the on-side ADS.

The ADS annunciators are listed in Table 5-4 below.

Table 5-4
Data Source Annunciators

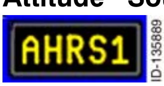
Copilot ADS	Pilot ADS	Copilot ADS Annunciator Color	Pilot ADS Annunciator Color
ADS1	ADS2	Blank	Blank
ADS1	ADS1	Amber	Amber
ADS2	ADS2	Amber	Amber
ADS2	ADS1		White

When the display control function fails, the display system reverts to on-side data. With the loss of valid information from the ADS, scale markings are not displayed from the altitude tape and are replaced by a red X.

ADS1 or ADS2 are not removed when a sensor fails.

ATTITUDE SOURCE ANNUNCIATORS

- **Attitude Source Annunciators** - The source of attitude information, either AHRS1 or AHRS2, is annunciated at the top of the ADI left of the zero index mark on the linear roll scale.



The annunciator is not displayed when both PFD are displaying information from the on-side AHRS.

When the pilot and copilot PFDs are displaying information from the same source, AHRS1 or AHRS2 (as appropriate) annunciates in amber on each PFD.

When there is a sensor failure, AHRS1 and AHRS2 are not removed.

NOTE: The current AW139/AB139 does not permit both pilots to select the cross-side AHRS.

The attitude source annunciators, listed in Table 5-5, lists how annunciators are displayed on the PFDs.

Table 5-5
Attitude Source Annunciator

Copilot Attitude Source	Pilot Attitude Source	Copilot Attitude Source Annunciator Color	Pilot Attitude Source Annunciator Color
AHRS1	AHRS2	**Blank**	**Blank**
AHRS1	AHRS1	**Amber**	**Amber**
AHRS2	AHRS2	**Amber**	**Amber**
AHRS2	AHRS1	**White**	**White**

EXCESSIVE ATTITUDE DECLUTTER

Under excessive attitude conditions, low priority display items are removed from the PFD. The following symbology is removed under excessive attitude conditions:

- Flight director mode annunciators and command bars
- Collective cue and reference markers
- CAT A bugs for airspeed, vertical speed and pitch reference
- Marker beacons
- Vertical deviation scale, pointer and annunciator
- Speed bugs and readout
- Ground speed
- Decision height minimum indication
- All flags including flight director fail flag, Lat/Vert deviation flags, speed target flags, and radio altitude flag
- All comparators except ATT, IAS, and ALT
- TCAS status annunciators
- TAWS status annunciators.

Excessive attitude conditions are listed in Table 5-6.

Table 5-6
Excessive Attitude Conditions

Bank	Pitch
Greater than ±65°	Greater than 30°
	Greater than 20°

The symbology restores under the conditions listed in Table 5-7.

Table 5-7
Symbology Restored Conditions

Bank	Pitch
Returns to less than ±63°	Returns to between 28° up and 18° down

MONITOR WARNING SYSTEM MISCOMPARE INDICATORS

The monitor warning system is designed to continuously compare data from systems with multiple redundancies such as the AHRS. When a performance discrepancy between the monitored systems are noted, the monitor warning system alerts the pilot by annunciating a miscompare indicator on the PFD. The miscompare annunciator has display priority over all other markings.

Miscompare annunciators are designed to alert the pilot to miscompare conditions. They are displayed as **amber reverse video** on the PFD. After they are initially displayed, they toggle between **amber reverse video** and **amber standard video** for the first six seconds. The **amber reverse video** annunciator remains steady after six seconds.

When the miscompare condition is no longer detected, the miscompare annunciator is no longer displayed on the PFD.

ATTITUDE MISCOMPARE ANNUNCIATORS

The monitor warning system continuously compares the attitude data from the two AHRS. When a performance discrepancy between the two AHRS is noted, the monitor warning system alerts the pilot by annunciating one of the following miscompare messages:

- **PITCH Miscompare** – This annunciator is displayed when the pitch attitude from the two AHRS disagrees by 5°.

- **ROLL Miscompare** – This annunciator is displayed for a roll attitude miscompare of greater than 6°.

- **ATT Miscompare** – This annunciator is displayed when both pitch and roll thresholds are exceeded. When AHRS attitude information is unreliable, the ATT miscompare is removed from the PFD.

NOTE: The miscompare annunciators above are described in further detail in the sections of this guide pertaining to each.

A loss of valid pitch or roll information from the AHRS is indicated on the display when the pitch tape, roll pointer, and flight director bars are not displayed. In addition, the boxed ATT, PITCH or ROLL annunciators are not displayed. The entire attitude sphere turns cyan and an ATT FAIL annunciator is displayed in the top of the attitude sphere when the data is invalid. When invalid data is due to an AHRS test, the ATT TEST annunciator is displayed instead of ATT FAIL.

VERTICAL DEVIATION DISPLAYS

The vertical deviation scale, as shown in Figure 5-10, is displayed on the right side of the ADI face. It is displayed when one of two conditions exist:

1. The vertical deviation scale is displayed when a localizer is tuned and identified. In this instance, the scale is the glideslope for the selected instrument landing system (ILS) approach.

2. Helicopters are equipped with a flight management system (FMS). The vertical deviation scale is displayed when the FMS is the primary navigation source and is producing reliable vertical deviation or preview vertical deviation.

NOTE: FMS produces two types of vertical deviation, one for VPTH and the second for VGP. The VGP vertical deviation can be presented as vertical deviation or preview vertical deviation.

- **Vertical Deviation Display** – When tuned to an identified ILS frequency, the pilot can use the display controller to select glideslope information for display on the vertical deviation scale from either the on-side or cross-side ILS.

The scale consists of a rectangle with two dots above and below it. The vertical deviation scale is displayed to the right of the attitude sphere as a pointer moving on a scale when LOC is selected.

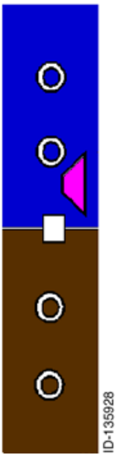
Each dot represents a graduation of 1.5° above or below glideslope on an ILS approach.

The display of the glideslope deviation pointer and scale are not displayed when the localizer backcourse (BC LOC) is active or armed on the flight director.

As shown in the example above, the glideslope deviation pointer or bug is a truncated cyan triangle displayed on the right side of the vertical deviation scale. The bug represents the position of the aircraft on the ILS approach in relation to the glideslope.

The rectangular box on the horizon line represents the position of the aircraft. The glideslope bug shows the pilot where the glideslope is in relation to the helicopter. When the bug is above the box on the display, the helicopter is below glideslope. When the bug is below the box on the display, the helicopter is above glideslope.

Using the position of the bug in relation to the dots, the pilot can estimate the number of degrees the aircraft is above or below the glideslope. When the bug is immediately adjacent to the box, the aircraft is on glideslope. In the example above, the aircraft is about 1° below the glideslope.



In helicopters equipped with a flight director, the **bug** is magenta when the flight director is coupled.

- **GS Miscompare** – The monitor warning system continuously monitors the glideslope. When a glideslope miscompare is detected, the system alerts the pilot by displaying the **GS** miscompare annunciator on the left side of the vertical deviation scale.

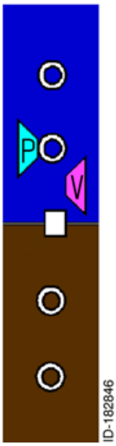
The **GS** miscompare annunciator has display priority over all scale markings. It toggles between **GS** and **GS** during the first six seconds. After six seconds, **GS** lights steadily. The annunciator does not display when a glideslope miscompare is no longer detected.

The loss of valid information from either NAV receiver does not display the **GS** annunciator.

VERTICAL NAVIGATION (VNAV) DISPLAY (FOR AIRCRAFT EQUIPPED WITH FMS)

CAUTION

VERIFICATION AND VALIDATION OF THE FMS FUNCTION HAS NOT BEEN COMPLETED. PENDING COMPLETION OF THE DEVELOPMENT OF THE FMS, IT MUST BE USED AS A SUPPLEMENTAL NAVIGATION AID. THE FMS MUST ALWAYS BE USED IN CONJUNCTION WITH ANOTHER NAVIGATION SOURCE THAT HAS BEEN CERTIFIED AS A PRIMARY NAVIGATION AID. EXAMPLES INCLUDE VOR/ILS, ADF, AND DME.



When the vertical navigation mode (VNAV) of the FMS is engaged, VNAV becomes the primary navigation source. In this instance, a cyan truncated triangle or vertical deviation indicator (**VDI**) bug is displayed on the left side of the deviation scale, as shown at left. The VDI bug moves vertically along the left side of the scale indicating deviation from the vertical path determined by the FMS.

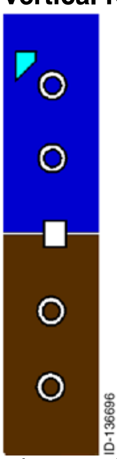
The following annunciator is displayed inside the pointer to indicate the type of vertical deviation being presented by the vertical deviation pointer:

- **V** (VNAV) for FMS VPATH vertical deviation
- **P** (PATH) for FMS VGP vertical deviation
- **I** (ILS) for ILS glideslope vertical deviation.

The vertical track annunciator (**VTA**) is displayed above the vertical deviation scale when it is driven by the displayed FMS. The **VTA** annunciator shares the same location as the **MIN** annunciator. However, the **MIN** annunciator has the highest priority.

There are two VNAV mode functions that can control the VDI bug. Each are described in the following paragraphs:

- **Vertical Navigation Mode – Deviation (VNAV DEV)** – When the FMS is operating, the VNAV DEV mode generates a vertical path (VP) for climbs and descents other than those associated with an approach. When climbing or descending to an assigned altitude, (in flight regimes other than an approach), the bug leaves the parked position when the aircraft is within $\pm$1000 ft ($\pm$ 300 ft for approach mode) of the VP.



The rectangular box on the horizon line of the scale represents the position of the aircraft in relation to the VP. The bug shows the pilot where the VP is in relation to the aircraft. When the VDI bug is above the box on the display, the aircraft is below VP. When the VDI bug is below the box on the display, the aircraft is above VP.

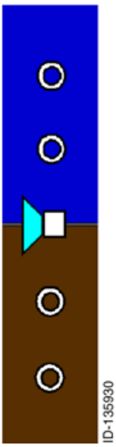
The pilot can estimate the number of feet the aircraft is above or below VP based on the position of the VDI bug in relation to the dots.

Each dot on the deviation scale represents $\pm$250 ft. In the example above, the VDI bug is displayed in the parked position above the horizon box. With the VDI bug parked in this position, the aircraft is 1000 ft or more below the VP. When the bug is parked, half of it is visible.

When the position of the bug is abeam, the second dot above the horizon box, the helicopter is 500 ft below the VP. At the first dot, the helicopter is 250 ft below the VP.

When the VDI bug is in the parked position below the horizon box, half of the bug is visible. This shows the aircraft 1000 ft or more above the VP. When the bug is positioned abeam, the second dot below the horizon box, it indicates the helicopter is 500 ft above the VP. At the first dot, the aircraft is 250 ft above the VP.

- **Vertical Navigation (VNAV) Mode - Approach (APP)** –The FMS VDI bug functions as a glideslope indicator when VNAV APP is functioning. The deviation scale values change becoming more sensitive to course and glidepath changes.



Unlike the VNAV DEV function, the VNAV APP function shows the position of the aircraft in relation to the glideslope. The glideslope of the selected VNAV approach becomes the VP with the horizon box that represents the aircraft. The dots above and below the box represent altitudes in feet above or below the VP.

For example, the parked position of the FMS bug in VNAV APP shows the aircraft 300 ft or more above or below the VP. The bug begins to move and leaves the parked position when the aircraft is within 300 ft of the VP.

The second dot above the aircraft represents 150 ft below the VP. The first dot above the aircraft represents 75 ft below the VP.

When the VDI bug is stationary at left of the horizon box, the aircraft is on the VP.

The VDI bug in the parked position below the aircraft shows the aircraft to be at 300 ft or more above the glideslope.

The second dot below the aircraft represents 150 ft above the glideslope. The first dot below the aircraft is 75 ft above the glideslope.

Vertical deviation scaling is listed in Table 5-8.

Table 5-8
Vertical Deviation Scaling

Pointer Position	VNAV DEV Input	VNAV APP DEV Input
Zero Index	0 ft	0μA
1 Dot Up	-250 ft	75μA
2 Dot Up	-500 ft	150μA
1 Dot Down	250 ft	-75μA
2 Dot Down	500 ft	-150μA
Parked	±1000 ft	±300 ft

Glideslope vertical deviation scaling is listed in Table 5-9.

Table 5-9
Glideslope Vertical Deviation Scaling

Pointer Position	GS DEV Input	GS DEV Output
Zero Index	0 DDM	0μA
1 Dot Up	0.0875 DDM	75μA
2 Dot Up	0.175 DDM	150μA
1 Dot Down	-0.0875 DDM	-75μA
2 Dot Down	-0.175 DDM	-150μA
Parked	±0.3500 DDM	±300μA

When vertical deviation information from the NAV receiver becomes unreliable or lost, the VDI bug is no longer displayed and an X overlays the vertical deviation scale.

When vertical deviation information from a previewed NAV source becomes unreliable, the VDI bug is not displayed. The VDI pointer and scale are not displayed when vertical deviation information from the FMS becomes unreliable.

- **Decision Height (DH)** – DH is displayed as a digital readout located below the VSI tape on the ADI.

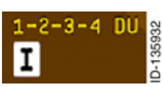
During power-up, the DH display defaults to white dashes (- - -). The DH is set in the cockpit using the on-side DC function. The first turn of the knob activates the DH display at 200 ft. Each knob click equals altitude changes in 10 ft increments. The DH display is not displayed for settings below 20 ft. An amber dashed (- - -) annunciator is displayed when DH setting is lost.

The range of DH data corresponds to the radio altitude range when below 2500 AGL (above ground level).

- **Minimums Annunciator** – In a descent, when the aircraft arrives at DH +100 ft, an empty **black box** with an amber outline is displayed in the upper right portion of the ADI. When the aircraft arrives at the selected decision height or descends below it, the MIN (minimum) indication at left shows in the box.

The MIN annunciator shares the same location as the VTA with MIN having higher priority. The DH indication is not displayed on the ground and through climb out until radio altitude is greater than DH +100 ft. When valid information from the avionics standard communication bus (ASCB) or DH is lost, the MIN indication is not displayed.

MARKER BEACONS



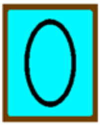
Outer (O), middle (M), and inner (I), marker beacon annunciators are displayed in the lower left corner of the ADI and are controlled by the selected NAV receiver (VOR/LOC).

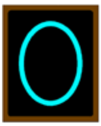
When the selected navigation source is not from the VOR/LOC, the marker beacon generates from the on-side NAV receiver.

The pilot is alerted to marker beacon passage by the beacon annunciator. As long as the aircraft is in the cone of sensitivity, the annunciator switches between reverse video for one second on and a half second off.

When multiple marker beacons are active, the priority display annunciator decreases order from I, M, O. Marker beacon annunciator lights are as follows:

- **Outer Marker** – Reverse video for one second on and standard video for a half second.


ID-135933


ID-135934

- **Middle Marker** – Reverse video for one second on and standard video for a half second.


ID-135935


ID-135936

- **Inner Marker** – Reverse video for one second on and standard video for a half second.


ID-135937


ID-135938

ALTIMETER DISPLAY

The altimeter shows barometric altitude, and MSL (mean sea level), located on the right side of the ADI, as shown in Figure 5-12. Altitude information from the air data system drives the display.

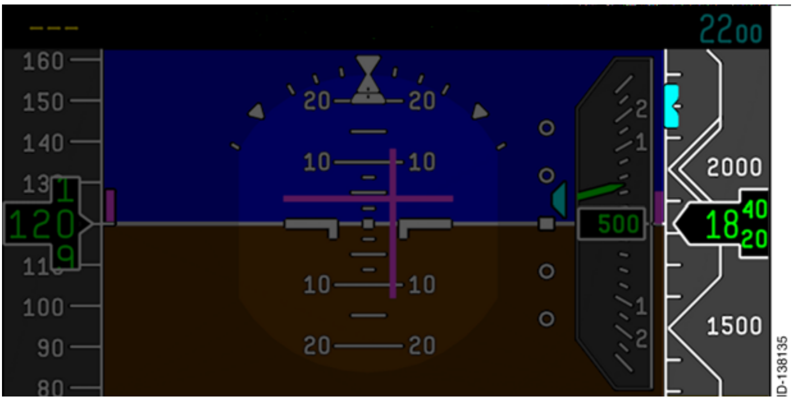
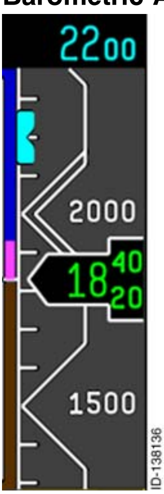


Figure 5-12
PFD Attitude Section - Altitude Tape

- **Barometric Altimeter Tape** - The altitude tape is arranged so a ±550-foot window is visible at all times. Digits appear in ascending order from the bottom to the top of the tape.



The tape scale is marked at 100-foot increments, except for increments that coincide with a chevron. The scale is marked with a numerical value every 500 ft.

A double line chevron marks each 1000-foot increment and a single lined chevron marks each 500-foot increment. The chevrons extend back to the approximate midpoint of the altitude tape and are connected to each other with a vertical line. The left side of the current value window is angled in the same manner as the chevrons.

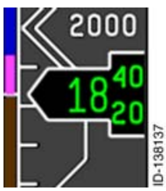
A green **digital readout** of the current altitude is displayed in the box at the center of the altitude tape. The last two digits in the rolling digits displayed are in 20-foot increments. The altitude range of the digital readout is between -2000 to +60,000 ft MSL.

The altitude tape can be set to display values in meters or feet. The metric value (one meter increments) display is directly above the current value altitude window. An M is displayed to the right of the readout. This function is selected from the MFD system menu. After selection or deselection of the metric value, the first click of the altitude select knob changes the preselect altitude to the nearest 20M or 50 ft multiple.

The NEG annunciator above the digital readout alerts the pilot when altitudes below sea level are being displayed.

A loss of valid altitude from the air data function shows a red X over the altitude tape and the scale markings are not displayed. In addition, a loss of valid altitude information from the ADS does not display digits in the rolling digital display

- **Trend Vector Indicator** – The altitude trend vector originates at the



the altitude reference line and indicates what the altitude trend will be in six seconds based on the current vertical speed. The trend vector is a magenta thermometer that corresponds to altitude rate in feet per minute (fpm). It moves along the left side of the altitude tape and reflects a raw data vertical speed indication. When the aircraft maintains the same vertical speed for the next six seconds, the projected number of feet climbed equals the number of feet at the end of the trend vector as read on the altitude scale.

The trend vector indicator and scale are not displayed with a loss of valid altitude information from the ADS.

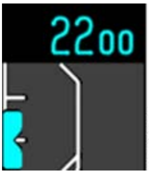
- **Baro Altimeter Setting** – The baro set window is located directly

below the altitude tape. Barometric pressure corrections are changed using the display control (DC) function using the cursor control device (CCD) and MFD menu. The pilot can choose to display the barometric pressure in either inches of mercury (inHg) or hectopascals (hPa). IN or HPA are displayed in the window along with the pressure value.

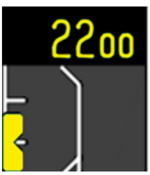
Following the loss of a valid display control function the baro set display continues to use the last displayed units. A flashing white BARO annunciation is shown on the altitude tape above the baro setting window when the displayed baro correction setting is changing and for six seconds after the change is complete. When displayed, the annunciation will flash such that it is toggling between white letters on a black background and black letters on a white background.

A loss of valid DC function continues to show the last displayed units. An amber dashed (- - -) annunciator shows when a valid baro set information is lost from the air data function.

- **Altitude Preselect Digital Readout** - A digital readout of the preselect altitude is displayed above the altitude tape. The readout ranges between -2000 to 51,000 ft MSL in 50-foot increments. A minimum of three digits are always displayed with leading zeros (when necessary). The digital display and bug are displayed in cyan.



ID-138140



ID-138140

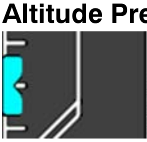
When altitude preselect is in flight director mode, the bug and digital readout are displayed in magenta for both the PFDs. When the altitude alert is active, or a departure from altitude has been made, the digital readout and bug turns amber.

An off-scale indication is displayed to indicate the direction the bug is off the scale. The off-scale indication is an arrow that shows the direction it is off the scale.

Conditions for an amber readout does not display the magenta flight director reference. When glideslope is captured, it takes precedence over the altitude departure indication.

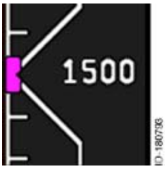
At power-up, the altitude preselect bug is removed and the digital readout remains blank until a value is selected. A loss of valid altitude select information from the DC shows amber dashes (- - -) on the digital display. The digital readout and bug are not displayed when valid altitude information is lost from the ADS.

- **Altitude Preselect Bug** - The altitude preselect bug is a cyan notched rectangle indicator that indicates the preselected altitude set on each PFD. Rotating the ALT SEL knob on the display controller moves the bug vertically along the left inside edge of the altitude tape and changes the altitude preselect digital readout. The color of the bug matches the color of the altitude preselect digital readout at all times.


ID-138139

The rate of altitude preselection varies with the rate the knob is turned. The slower the knob is turned, the more precise the ability to set the selection. Each click of the knob informs the pilot of a 50-foot change in setting.

- **Altitude Reference Bug And Readout** – The altitude reference bug is displayed on the altitude tape when the altitude hold flight director mode is engaged. The altitude reference bug is a magenta notched rectangle that is smaller than the altitude select bug. The set point is determined by the priority flight director.



The altitude reference bug is not displayed when valid information from the ADS and priority flight director is lost.

The altitude bug is displayed in magenta on both the pilot and copilot PFD when the altitude alert function is not in an active state. The bug is displayed in amber when the altitude alert function is in an active state.

The altitude reference digital readout is shown directly above the altitude tape when any of the following conditions occur:

- For the first six seconds after the altitude hold mode is engaged as vertical pitch or vertical collective mode.
- When the digital readout for the altitude preselect is not shown and when the flight director is using an altitude reference.
- When the flight director is using an altitude reference and altitude reference is changing.

The set point is determined by the onside flight director. The altitude reference digital readout shares the same location and has higher priority than the altitude preselect digital readout.

When the metric altitude is deselected, the digital readout of the altitude reference is rounded to the nearest 10 foot increment.

When the metric equivalent of the current altitude reference (in feet) and is shown rounded to the nearest meter.

A loss of valid altitude information from the ADS or loss of valid altitude reference information from the flight director causes the altitude reference readout and the bug to be removed.

- **Barometric Altimeter Low Altitude Alert Display** – The low altitude awareness display (LAAD) is an area of brown shading bordered by an amber line that advances or recedes vertically along the altitude tape with changes in absolute altitude below 550 ft AGL. The display repeats the data from the LAAD display from the radio altitude scale described in the following paragraphs. All data for the LAAD is derived from the radio altitude.

ID-138143

As the aircraft descends though 550 ft AGL, the low altitude awareness display comes into view, initially presenting the amber line. As descent is continued, the amber line advances along the airspeed tape, closing with the centerline, leaving the tape shaded brown behind it.

The centerline of the airspeed tape corresponds to the artificial horizon line on the ADI. The advance of the amber line and brown shading along the altitude tape represents the aircraft getting closer to the ground. The lower the altitude (AGL), the greater area of shaded brown displays.

The example at left shows the aircraft on the ground at sea level. The lower portion of the altimeter tape is shaded brown and the present altitude window indicates an MSL altitude of zero feet.

Any gray portion of the altitude tape between the amber line and the artificial horizon represents absolute altitude AGL.

When continuous flight is conducted below 550 ft AGL, the brown shading advances or recedes as the pilot introduces changes to the absolute altitude of the helicopter.

Below 550 ft AGL, in straight and level flight, the awareness display reflects variations in terrain height passing beneath the helicopter. The lower portion of the altitude tape is filled by shaded brown when the aircraft is at 0 ft AGL.

A loss of valid radio altitude removes the amber line and the low altitude awareness display.

- **ALT Miscompare Annunciator** – The pilot is alerted to an existing

altitude miscompare by displaying an **ALT** annunciator inside the top half of the altitude tape. The ALT miscompare annunciator has display priority over all scale markings. It toggles between **ALT** and **ALT** during the first six seconds, **ALT** is displayed steadily. The annunciator is removed when an altitude miscompare is no longer detected.

The **ALT** annunciator is displayed when a BARO ALT miscompare is detected. It toggles between **ALT** and **ALT** during the first six seconds, **ALT** is displayed steadily. The annunciator is removed when the BARO ALT miscompare is no longer detected.

The **ALT** miscompare annunciator has display priority over the **ALT** annunciator. The removal of the **ALT** annunciator is due to a loss of valid altitude information from the air data function.

AIRSPEED DISPLAY

Airspeed information, as shown in Figure 5-13, is displayed on the airspeed tape located to the left of the ADI.

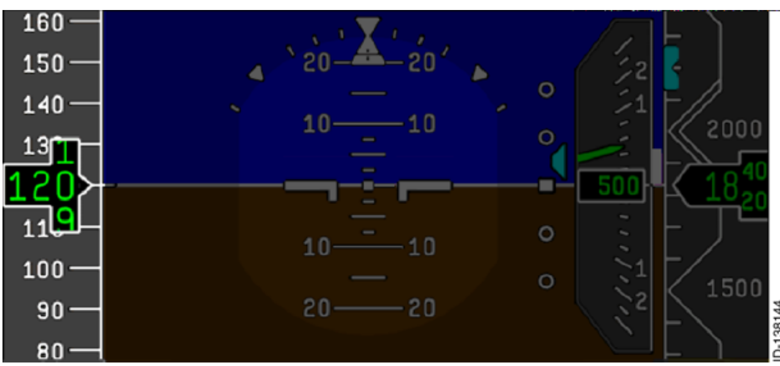


Figure 5-13
PFD Attitude Section – Airspeed Tape

- **Airspeed Tape** – Airspeed information is selected from the on-side or cross-side ADS using the ADS control switch on the reversion control panel. When the DC function fails, the display system reverts to on-side data.

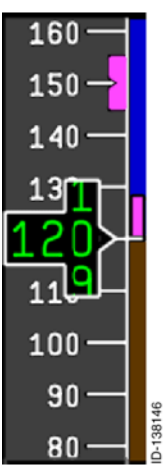
The airspeed tape continuously shows an 80 knot window, 40 knots above center and 40 knots below. The higher airspeed is at the top of the scale and decreases toward the bottom.

The right side of the tape is graduated in 10-knot increments. At airspeeds below 200 knots, each 10-knot increment is labeled. Airspeeds above 200 knots are labeled at 20-knot increments.

The current airspeed window is positioned in the center of the airspeed tape. It shows the current calibrated airspeed using green rolling digits.

The last digit of the current airspeed indicator rolls in one-knot increments. The right side of the current airspeed window is notched to fit the airspeed reference bug.

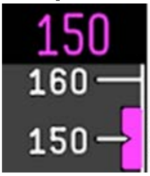
- **Airspeed Trend Vector Indicator** – An airspeed trend vector indicator is supplied with the airspeed tape. It is a rectangular magenta thermometer-type bar that travels vertically on the right outside edge of the airspeed tape. The bar indicates acceleration as it travels up the tape, and deceleration as it travels down the tape.



The indicator is not displayed when calibrated airspeed is less than 60 knots for one second or when airspeed acceleration is less than 0.0417 knots/second.

The algorithm for trend is a filter made up from airspeed, sine of pitch, and longitudinal acceleration. The trend vector indicator is not displayed when there is a loss of valid calibrated or indicated airspeed from the ADS, or when invalid longitudinal acceleration or pitch information comes from the AHRS.

- **Airspeed Digital Readout** – With the flight director engaged, a magenta airspeed reference **digital readout** is displayed directly above the airspeed tape when the IAS mode is engaged. The digital readout is set by the pilot using the priority flight director.



ID-138147

  The example at left shows **150** knots displayed digitally at the top of the airspeed tape. The airspeed reference bug is positioned on the airspeed tape at the corresponding airspeed. When the speed target is off scale, the direction that is off the scale is indicated.

- **Airspeed Bug** – The **airspeed bug** is a rectangular magenta bug with a V-shaped notch on the inside edge that travels vertically along the right inside edge of the airspeed tape. The position of the bug changes to correspond with the speed target input into the speed target digital readout indexed above the airspeed tape.

  In helicopters equipped with a flight director, and the flight director IAS mode is selected, the **airspeed bug** is magenta on both the PFDs.

ID-138148

  When a loss of reliable calibrated airspeed from the ADS, or a loss of speed reference from the priority flight director, the digital readout shows an amber dashed (**- - -**) annunciator and the airspeed bug is not displayed.

- **Ground Speed** – Ground speed is displayed in digital form using AHRS/GPS, FMS or Doppler velocity sensor data. The ground speed display is located at the bottom of the airspeed tape. It shows the ground speed value rounded to the nearest knot, and is limited to the range of 0 – 999 kts. It is preceded by the **GS** identifier.

ID-148796

  The ground speed is automatically source selected using the following priority sequence from highest to lowest.

  — The integrated AHRS/GPS velocity from the AHRS currently selected as the source for display of attitude and heading on the PFD

  — The offside AHRS/GPS

  — The Doppler velocity sensor

— The currently displayed FMS or from the last displayed FMS when FMS is not currently selected as the navigation source.

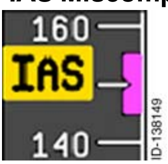
The displayed ground speed is filtered using a lag filter with a one second time constant when the selected ground speed is AHRS/GPS or Doppler.

When a Doppler velocity sensor is installed, the pilot can manually select the Doppler system as the priority ground speed sensor. When Doppler is selected as the priority ground speed sensor, the ground speed display prioritizes the source selection of the Doppler velocity sensor above the AHRS/GPS.

The currently selected ground speed source is annunciated by appending a G, or F to the end of the ground speed readout field to indicate respectively the source selection of GPS, or FMS.

When valid ground speed information from the FMS is lost, the readout shows amber dashes (such as, GS - - -).

- **IAS Miscompare Annunciator**– The pilot is alerted to an existing indicated airspeed miscompare when the IAS miscompare annunciator shows on the inside top half of the airspeed tape.

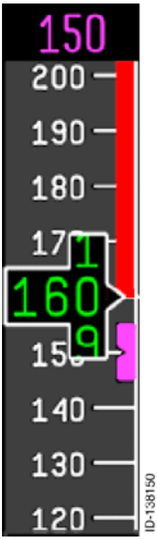


The IAS miscompare annunciator has display priority over all scale markings. It toggles between IAS and IAS during the first six seconds. After six seconds, IAS is displayed steadily, as shown here. The annunciator is removed when an indicated airspeed miscompare is no longer detected. IAS miscompare is not displayed when the CAS is less than 60 knots for one second.

The display system reverts to on-side data when the display control function fails. A loss of reliable calibrated airspeed from the ADS does not display the digits in the airspeed window and a red X replaces the airspeed tape.

NOTE: Red indicators take priority over amber indicators.

- **V_{NE} and Autorotation** – A red bar symbol shows on the speed tape to cue the pilot of airspeed approaching **V_{NE}** during multiengine or all engines operating (AEO) flight.



  At five knots prior to exceeding **V_{NE}**, the red bar symbol becomes visible extending vertically along the right inside of the airspeed tape from the **V_{NE}** indicator to the end of the tape in the direction of increasing airspeed.

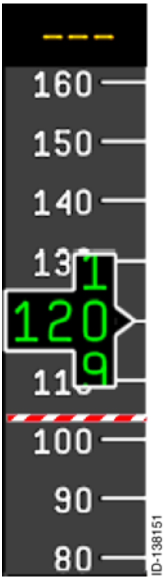
  When **V_{NE}** is exceeded, the **V_{NE}** red bar becomes thicker to alert the pilot that the aircraft is in an overspeed condition.

  The **V_{NE}** barber pole, shown in the following example, becomes visible during single engine operations, one engine inoperative (OEI) flight, and autorotation.

  The barber pole extends through the airspeed tape at **V_{NE}** for the existing autorotation condition.

  At five knots prior to exceeding **V_{NE}**, the horizontal barber pole is located vertically along the right inside of the airspeed tape. It extends from the AEO **V_{NE}** indicator to the end of the tape in the direction of increasing airspeed.

When V_{NE} is exceeded, the V_{NE} barber pole becomes thicker, alerting the pilot that V_{NE} has been exceeded.



The current airspeed digits are displayed in red inverse video when V_{NE} is exceeded by one knot.

The current airspeed digits are displayed in amber inverse video when calibrated airspeed and the trend vector exceeds V_{NE}.

Red indicators take priority over amber inverse video indicators.

A loss of reliable calibrated airspeed from the ADS does not display the V_{NE} indication or the digits in the value window.

VERTICAL SPEED DISPLAY

Vertical speed information, as shown in Figure 5-14, is displayed on the digital VSI positioned on the right side of the ADI.

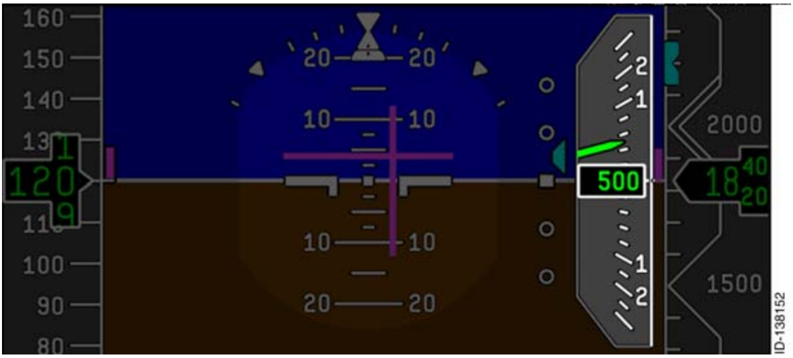


Figure 5-14
PFD Attitude Section - Vertical Speed Indicator (VSI)

Vertical speed information is selected from the on-side or cross-side ADS using the ADS reversion switch. When the DC function fails, the display system reverts to on-side data.

The vertical speed indicator (VSI) shows altitude rate of change in feet per minute (fpm) and consists of a vertical speed scale, digital readout, and target speed bug.

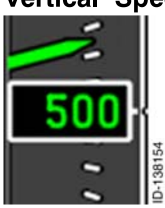
- **Vertical Speed Scale** - The vertical speed scale shows a vertical speed range between ±3000 fpm with a green pointer indicating the current vertical speed. The resolution of the VSI scale is enhanced between ±1000 feet/minute.

  The vertical speed scale shows a vertical speed range between ±3000 fpm with a green pointer indicating the current vertical speed. The resolution of the VSI scale is enhanced between ±1000 fpm.

  When vertical speed exceeds ±3000 fpm, the VSI pointer parks at the ±3000 fpm position on the scale.

  The scale is graduated into 200 fpm increments between ±1000 fpm. It is labeled at the ±1000 fpm and ±2000 fpm graduations with a single digit representing the value in thousands.

- **Vertical Speed Digital Readout** - The vertical speed digital readout is positioned at the center of the vertical speed scale. Using green digits, it shows the vertical speed that corresponds to the speed indicated by the VSI needle.



  The vertical speed digital readout is removed from view when the vertical speed is between -300 fpm and +300 fpm.

  The digital readout is graduated in 50 fpm increments. It is shown at 300 fpm as vertical speed increases. It is removed from view at 250 fpm as vertical speed decreases.

  A loss of reliable vertical speed information from the ADS does not display the vertical speed digital readout, and scale markings from the window. An X is placed over the vertical speed display.

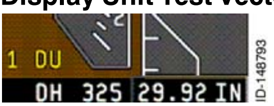
- **Vertical Speed Target** – The **vertical speed target**, is a magenta notched rectangular bug that moves vertically on the right side of the VSI scale. When the selected vertical speed and the actual vertical speed are the same, the head of the VSI needle fits into the notch of the target bug.

The magenta vertical speed target **digital readout** is displayed above the VSI speed scale. The data for the readout is supplied from the priority flight director when the flight director vertical speed (VS) mode is engaged.

The digital readout is rounded to the nearest 50 fpm for targets of 1000 fpm or less. It rounds to the nearest 100 fpm for targets greater than 1000 fpm. Climb and descent speed targets are indicated with an arrow pointing up or down (↑↓) immediately to the right of the vertical speed target digital readout.

The speed target bug and readout are not displayed when there is a loss of valid vertical speed information from the ADS. In addition, a loss of vertical speed target information from the flight director does not display the speed target bug and digital readout.

- **Display Unit Test Vector Annunciator** – The display unit graphics software computes and transmits on the ASCB. A cyclic redundancy check (CRC) that is computed from a predetermined set of graphic commands/symbols. This CRC is independently received by the monitor warning function (MWF) and compared to the known result. When the CRC does not match, or it is not received by the MWF, a **1-2-3-4 DU DEGRADE** CAS message is displayed together with a **1-2-3-4 DU** annunciator at the bottom right of the attitude sphere. This graphics test data monitor is not unique to any parameter. It assures that the processor can produce the predetermined graphics command symbols. The CRC consists of a set of graphic objects, pointer, readout, ADI, and tape.



DU DEGRADE CAS message and the **DU** annunciators are not displayed on the PFD when invalid information from the MWF is detected.

- **Cyclic Position Display** – The cyclic position display is located on the left of the ADI and right of the airspeed tape on the PFD. The cyclic position helps the pilot center the cyclic controls before starting the engines. This ensures that the rotor system does not hit the static stops when rotating at low speeds.

The cyclic position shows **CYCLIC** when the aircraft is on the ground and the collective is less than 20%. The **directional arrows** are displayed in amber when the cyclic position is not in the desired center position. The **center spot** is displayed in green when the cyclic is in the center position.

The cyclic is considered in the center position when the pitch trim servo position is within 50 $\pm$ 1.5° and the roll trim servo position is within 45 $\pm$ 1.25°.

When the pitch trim servo position is less than 48.5°, the up directional arrow is displayed in amber to indicate the cyclic must be moved aft for centering. Similarly, when the roll trim servo position is greater than 46.25°, the right directional arrow is shown in amber to indicate that the cyclic must be moved left for centering.

HORIZONTAL SITUATION DISPLAY

The horizontal situation display portion of the PFD, as shown in Figure 5-15, shows situational reference and engine indicating and crew alerting system (EICAS) information. In addition, it is used to control communications and navigation radios.

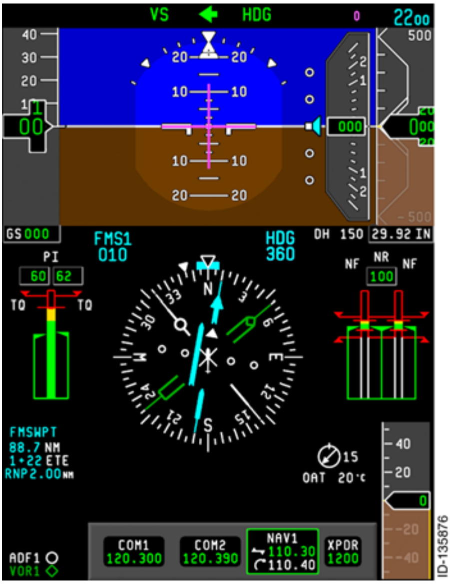


Figure 5-15
Typical PFD With HSI - Full Compass Format

The display consists of elements that are designed to communicate essential information using graphics, text messages, and unique symbols shown at different locations on the display.

The HSI has three distinct formats, as selected by the display controller. The full compass format, as shown in Figure 5-16, presents a 360-degree display overlaid with navigation data given by the bearing pointers and course deviation indicator. The hover format, as shown in Figure 5-17 presents the aircraft longitudinal and lateral velocities with the FMS map on a 360-degree display. The ARC mode, as shown in Figure 5-19, shows an expanded quadrant of the compass rose.

Full Compass Format

The full compass format, as shown in Figure 5-16, shows a 360-degree compass that is overlaid with navigation data supplied by bearing pointers and the course deviation indicator (CDI).

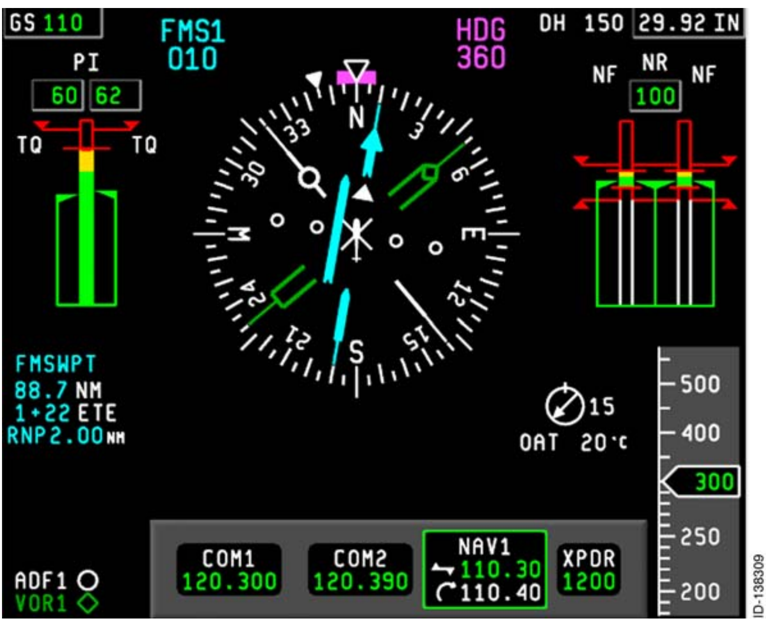


Figure 5-16
Horizontal Situation Indicator (HSI) - Full Compass Format (Typical)

Hover Display Mode

The hover display mode gives the pilot a display of the aircraft longitudinal (along the heading) and lateral (across the heading) velocities and a flight director velocity reference bug. The hover display, as shown in Figure 5-17, permits overlay of the FMS map data to give situational awareness during the hover. The hover page is selected by toggling the HSI button until the hover page is displayed. It is automatically displayed when either the hover (HOV) or mark on target (MOT) flight director modes are selected.

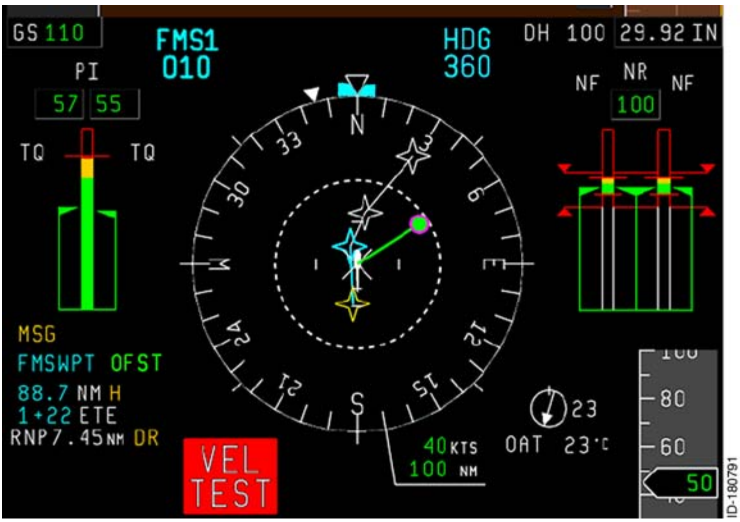


Figure 5-17
Typical Hover Display Mode

HOVER DISPLAY MARKING AND SCALE

The HOV display mode is presented as a heading up (full 360 degrees), compass rose.

NOTE: The hover format compass rose is decluttered by displaying the 10-degree increment tick marks. The five-degree tick marks, normally shown on a compass rose, are not included. In the hover format, the HSI display is expanded to the fullest extent.

The following items are removed from display in the hover display mode:

- The course pointer for both the primary and preview navigation source

- The lateral deviation pointer and scale for both the primary and preview navigation source
- To/From display
- Bearing pointers (the bearing pointer labels remain displayed).

The outer ring of the compass rose forms the boundary of the velocity vector scale and gives the outer range ring for the map overlay on the hover display. The full scale range of the hover display for both the velocity and distance indications are annunciated.

The hover display has a dashed circle to mark the 50% scale ring using a dashed line. A 25% scale ring has tick marks, fore, aft, right, and left of the helicopter symbol.

The labels for the velocity and map range scales are annunciated below and to the right of the HSI with a line linking these to the outer edge of the compass card.

When the heading from the selected source is invalid, tick mark lables are removed and a HDG FAIL annunciator is displayed at the top of the compass rose. When the heading is tested from the selected source, a HDG TEST annunciator is displayed at the top of the compass rose.

A loss of valid velocity data from the AHRS and valid velocity reference from the priority flight director has amber dashes (- - -) displayed in place of the velocity range label. The map range readout displays the last valid range data when the display control function is indicated as invalid.

HOVER DISPLAY VELOCITY INDICATIONS

The hover display presents the aircraft longitudinal and lateral velocities in the form of a velocity vector drawn from the aircraft symbol in the direction of the ground speed. A small circle is placed at the end of the velocity vector to highlight the end of the vector.

The hover page shows a ground speed bug in the form of a small circle to indicate the velocity reference from the priority flight director. The velocity reference bug is displayed when the flight director mode is using the hover velocity reference.

The hover page, as shown in Figure 5-18, implements velocity ranges of 10, 20, 40, and 80 knots. The page automatically selects a scale for the velocity indications using the larger value of the current velocity or the reference bug velocity.

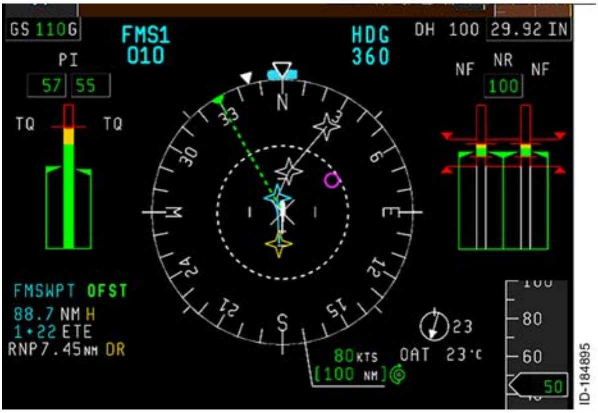


Figure 5-18
Hover Display out of Range Indication

The selected velocity scale increases when the higher value of the velocity vector or the reference bug reaches 90% of the current scale. The selected velocity scale decreases when the higher value of the velocity vector or reference bug reaches 70% of the next lower scale.

When the aircraft ground speed is greater than 80 knots, the velocity vector is displayed as a dotted line, with a half circle at the end indicating that the pointer is railed against the edge of the scale. This permits the pilot to continue to see ground speed direction.

The hover velocity vector source selects the velocity data from the same source as is selected for the digital readout of ground speed.

When FMS is selected as the velocity source for the digital display because the other velocity sources are invalid, the velocity vector does not display.

When valid velocity data from an AHRS or Doppler source is not available, the velocity vector on the hover display is removed and a VEL FAIL annunciator is displayed below and to the left of the compass rose.

When velocity is reported in test from an AHRS or Doppler source, a VEL TEST annunciator is displayed below and to the left of the compass rose. When the FMS is selected as the velocity source for the digital velocity display, the display of the velocity vector is inhibited and the VEL FAIL annunciator is displayed.

The velocity reference bug is removed from the display when the reference values from the AFCS are invalid or out of range. The velocity reference bug is out of range when the flight director velocity reference is greater than 80 knots.

HOVER DISPLAY NAVIGATION SOURCE

The FMS is always used as the navigation source when the hover display is selected. Selection of the hover format is inhibited when a non-FMS navigation source is selected or previewed.

HOVER DISPLAY MAP OVERLAY

When the HOV display mode is selected on the HSI, pushing the **MAP** button toggles ON and OFF the display of the map overlay.

When the hover display map is enabled, the hover display page presents an FMS stick map with the flight plan waypoint shown at the appropriate range and bearing and linked together with line and arc segments per the FMS flight plan. The map on the hove page is displayed using the waypoint, navigation aids and airport symbols as appropriate for each point in the flight plan. The hover display map overlay does not show navigation aids, airports, or heliports unless these items are part of the flight plan. Waypoint identifiers are not displayed on the hover map page.

HSI Compass ARC Format

The arc format, as shown in Figure 5-19, shows a section of the full compass that is 45° either side of the current heading. It has navigation data supplied by bearing pointers and the CDI.

Figure 5-19
HSI - Compass ARC Format

NOTE: There are four functions that can be displayed in the ARC mode that cannot be displayed in the full compass mode. They are weather, TAWS, TCAS, and flight plan.

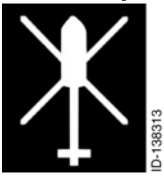
HORIZONTAL SITUATION INDICATOR (HSI)

- **Compass Rose** – The cardinal points of the compass rose are marked **N**, **E**, **S**, and **W** respectively. The 90° quadrants between the cardinal points are further graduated into 30° increments. For example, at left, the southeast quadrant is marked at the 120° point with the number **12**. The 150° point is marked with the number **15**.

Between the 30° markings, each 10° graduation is marked with a **long white line**. Each 5° graduation is marked with a **short white line**.

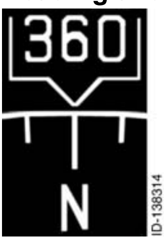
When the heading from the selected source is invalid, tick mark lables are removed and a **HDG FAIL** annunciator is displayed at the top of the compass rose. When the heading is tested from the selected source, a **HDG TEST** annunciator is displayed at the top of the compass rose.

- **Aircraft Symbol** – A fixed aircraft symbol is displayed at the bottom



of the compass arc as an aid in visualizing the position of the aircraft in relation to horizontal navigation information that is displayed. In the full compass display, the aircraft symbol is in the center of the compass.

- **Heading and Digital Readout** – The aircraft heading is indicated



by movement of the compass rose with respect to the lubber mark at the top of the compass. Left turns rotate the compass rose clockwise. Right turns rotate the compass rose counterclockwise.

In the arc compass mode, the aircraft heading is numerically displayed inside the heading indicator, as shown to the left. Heading information is displayed by each AHRS.

- **Lubber Mark** – The aircraft heading is indicated by movement of the compass rose with respect to a lubber mark at the top of the compass. In full compass mode, an unshaded inverted triangle (∇) is displayed at the top of the compass to give a lubber. In arc mode, a box with a digital readout of current heading is displayed. The bottom of the box is notched to indicate the lubber line. The notch and the inverted triangle are designed to fit inside the heading bug when they are aligned.

- **Heading Source** – The heading source is annunciated when both

pilots have the same source selected, or when directional gyro (DG) mode is selected.

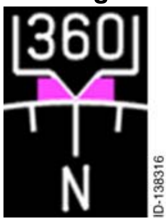
When the on-side heading source is displayed on each PFD, no source annunciator is displayed unless the DG mode has been selected. In this case, DG 1 annunciates the copilot PFD and DG 2 annunciates the pilot PFD.

Selecting AHRS1 with the reversion controller has MAG1 or DG 1 displayed on each PFD. Selecting AHRS2 has MAG2 or DG 2 displayed on each PFD.

Amber dashes (- - -) replace the digital readout when the selected heading source becomes unreliable.

The heading source annunciator is displayed following an AHRS failure.

- **Heading Select Bug** – Both HSI compass formats display a heading bug that is capable of 360 degrees of motion. The heading bug is a rectangle with a triangular notch positioned on the outside of the compass rose. It selects a desired aircraft heading. When heading select is engaged, the **heading bug** is displayed in magenta.



  The example shows the heading indicator lubber mark is resting in the triangular notch of the heading bug indicating the actual heading and the selected heading of the aircraft is 360 degrees.

  A cyan **heading bug** indicates the flight director is not coupled.

  The heading select knob of the remote instrument controller (RIC) changes position of the heading bug on the perimeter of the compass rose. When the flight director is in heading (HDG) mode, commands are generated that align and maintain the aircraft on the heading selected by the bug.

- **Yaw Heading Hold Reference Bug** – The **yaw heading hold reference bug** is displayed on the HSI heading scale tape when the flight director indicates that the yaw heading hold is functional.

  The yaw heading hold reference bug is shaped like a notched rectangle, but is smaller than the heading select bug. The set point is determined by the priority autopilot.

  The yaw heading hold reference bug has visual priority over the heading select bug. Both the yaw heading hold reference bug and the heading select bug can be displayed simultaneously so the visual priority ensures that the heading select bug does not completely mask the yaw heading hold reference bug.

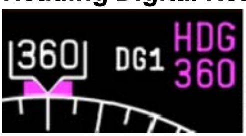
  A loss of valid heading information from the AHRS or a loss of valid yaw heading hold reference information from the priority autopilot causes the yaw heading hold bug to be removed.

- **Off Scale Arrows** – The heading bug travels 360 degrees around the compass and can be repositioned out of view on the compass arc mode .

ID-138318

As shown in the example on the left, when the heading bug is positioned out of view, an arrow (←) that matches the color of the heading select bug is displayed outside the arc pointing to the shortest direction to turn to the bug. The arrow is removed when the heading bug is displayed.

- **Heading Digital Readout** – As shown to the left, a digital readout, positioned to the right of the heading indicator, shows the heading currently indicated by the bug. The **heading bug** and **digital readout** are magenta, alerting the pilot that the flight director HDG mode is engaged and reliable. The lubber point of the heading indicator is aligned in the notch of the magenta **heading bug** indicating that the aircraft is on a selected course of 360 degrees.

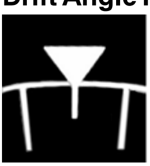


ID-138319

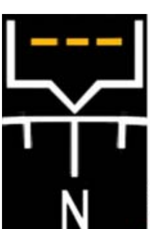
ID-138320

The cyan **heading bug** and digital readout alert the pilot that the flight director HDG mode is not engaged.

- **Drift Angle Pointer** – The white, triangular, **drift angle pointer** is shown at left. It is displayed on the outside of the compass arc to indicate ground track angle necessary to maintain course.


ID-138321

A loss of reliable heading information from the AHRS, or track angle information from the FMS does not display the drift angle pointer.



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The pilot is alerted to the loss of reliable heading information from the AHRS with amber dashes (- - -) replacing the heading readout in the heading indicator and the heading bug is not displayed.

- **Heading Miscompare Annunciator** – A 10-degree miscompare

between the two AHRS shows the HDG miscompare annunciator. HDG annunciates on the ADI portion of the PFD just below and to the left of the VSI.

  The HDG miscompare annunciator has display priority over all scale markings. It toggles between HDG and HDG during the first six seconds. After six seconds, the HDG shows steadily. The annunciator is not displayed when a heading miscompare is no longer detected.

  A loss of reliable heading information from the AHRS, or monitor warning system does not display the HDG annunciator.

- **Course Pointer** – The course pointer is a segmented needle that

is superimposed over the HSI compass display. It represents a selected short-range navigation course (CRS) or FMS desired track (DTK) and the helicopter position relative to it. The dots are always white, and the pointer is cyan when the flight director is not coupled, and magenta when the flight director is coupled.

  The course pointer pivots around a center point that corresponds to the center of the compass card. The center position is marked by the aircraft symbol. When the FMS is selected, the course pointer is controlled by the FMS, and it is set to the desired track. Once a course is selected, the needle turns with the compass card and aligns with the lubber mark when the helicopter heading is the same as the selected course. The course pointer can be rotated 360° clockwise, and counterclockwise using the course select knob on the on-side remote instrument controller.

  The first segment of the course pointer is topped with an arrowhead shaped pointer that indicates the course selected by the pilot.

  The tail segment of the needle falls on the reciprocal of the course indicated by the head of the needle or course pointer.

- **Electronic Display System (EDS) Course Error Output** – The EDS function gives a course error output on the avionics standard communication bus (ASCB) for use by the automatic flight control system (AFCS). The error output is the difference between the current heading and the course selected by the pilot using the display controller.

When VOR/ILS is the primary navigation source, the course selected by the display controller is displayed on the course pointer.

When the FMS is selected as the primary navigation source, the course pointer shows the FMS desired track. However, the EDS course error output shows the difference between the aircraft heading and the selected course.

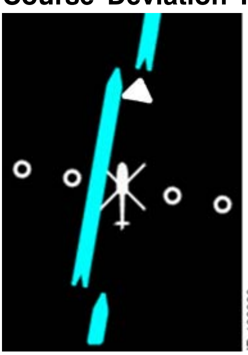
When VOR/ILS is selected as the preview navigation source, the pilot selected course is displayed on the preview course pointer.

The course error always computes the angle difference between the pilot selected course and the aircraft heading irrespective of the selected primary navigation source.

Removal of the course/desired track pointer and digital readout is replaced with amber dashes (- - -) when valid information from the DC function, or valid heading from the AHRS is lost. In addition, the primary navigation source is from a short-range NAV (VOR or LOC).

When the FMS is selected as the primary navigation, a loss of valid heading information from the AHRS, or a loss of information from the displayed FMS does not display the CRS/DTK pointer. Amber dashes (- - -) replace the CRS/DTK readout.

- **Course Deviation Indicator (CDI)** - The CDI indicates lateral deviation from the centerline of a selected course. As shown at left, the CDI is composed of the course pointer segmented needle and a scale centered on a helicopter symbol. The deviation bar (middle part of the segmented needle) indicates course deviation by moving laterally on a scale consisting of four dots. Two on the left and two on the right of the helicopter symbol. The pointer parked position equals 2-1/2 dots. The course deviation bar and scale rotate by turning the course knob on the on-side remote instrument controller.



ID-138328

  - **VOR Deviation** - The PFD shows data from the on-side or cross-side VOR receiver as selected by the DC function. VOR scaling is listed in Table 5-10. For VOR deviation, the pointer parks at ±20 degrees.

    The pointer is not displayed and the scale is overlaid with an amber X when valid bearing information from the NAV receiver, or valid heading from the AHRS is lost.

- **Localizer Deviation** – The PFD shows data from the on-side or cross-side localizer from the DC function when the NAV receiver is tuned to a localizer frequency. Localizer scaling is listed in Table 5-10. The pointer parks at ±.31 difference in depth modulation (DDM).

  The pointer is not displayed and the scale is overlaid with an amber X when valid localizer deviation information from the NAV receiver is lost.

- **FMS Lateral Deviation** – The PFD shows navigation data from the FMS when selected by the DC function. When the selected NAV source is from the FMS, the lateral deviation pointer is scaled as a function of the FMS required navigation performance (RNP) as listed in Table 5-11.

The deviation bar is not displayed, and the lateral deviation scale is overlaid with an amber X when valid lateral deviation from the FMS is lost.

Two dots on either side of the helicopter symbol indicate the amount of course deviation. Deviation scaling is listed in Tables 5-10 and 5-11.

Table 5-10
VOR Deviation Scaling

Pointer Position	VOR DEV Input	VOR DEV OUTPUT
Zero Index	0°	0μA
1 Dot Up	-5°	75μA
2 Dot Up	-10°	150μA
1 Dot Down	5°	-75μA
2 Dot Down	10°	-150μA

Table 5-11
FMS/LOC Deviation Dot Definitions

Pointer Position	Deviation
LOC Deviation	
Zero Index	0 Difference in Depth Modulation (DDM)

Table 5-11 (cont)
FMS/LOC Deviation Dot Definitions

Pointer Position	Deviation
One Dot Right	0.0775 DDM
Two Dots Right	0.155 DDM
One Dot Left	-0.0775 DDM
Two Dots Left	-0.155 DDM
FMS Deviation	
2.5 Dots Right	-2 Required Navigation Performance (RNP) NM
2 Dots Right	-1 RNP NM
1 Dot Right	-0.5 RNP NM
0 Index	0 RNP NM
1 Dot Left	0.5 RNP NM
2 Dots Left	1 RNP NM
2.5 Dots Left	2 RNP NM

- **Off Scale Arrows** – When the compass arc format is in use and the course pointer is rotated off scale as in the example at left, a cyan arrow ( ) is displayed showing the shortest turn direction to the head of the needle. The arrows ( ) are magenta when the flight director is engaged.

ID-148840

The arrow is removed when the CDI returns to view.

- **NAV Source** – The selected navigation source legend is positioned at the upper left of the compass card immediately above the digital course readout. The NAVAIDs available for display are: VOR1, VOR2, FMS1, FMS2, LOC1, and LOC2.

ID-138327

NOTE: Aircraft installed with one FMS has the digital readout displayed when the FMS is selected.

The navigation source display color schemes are listed in Table 5-12.

Table 5-12
NAV Source Color Scheme

Color	Condition
Cyan	Selected NAV source when not coupled to the flight director. Color priority No. 3.
Magenta	Selected NAV source when coupled to the flight director. Color priority No. 2.
Amber	Source annunciators when pilot and copilot have selected the same NAV source. Color priority No. 1.

The VOR1, FMS1, or LOC 1 legend is displayed when navigation data is from the number one side. The VOR2, FMS2, or LOC2 legend is displayed when navigation data is from the number two side.

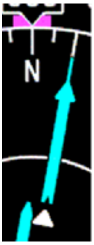
The VOR1 or VOR2 legend is displayed when VOR/LOC mode is selected and the NAV source is not tuned to a localizer frequency. When the NAV source is tuned to a localizer frequency, the LOC1 or LOC2 annunciator is displayed. The FMS1 or FMS2 annunciator is displayed when the FMS is selected as the NAV source.

A digital readout legend of the selected course or track is displayed at the top of the compass arc to the left of the heading indicator immediately below the associated NAVAID.

The example at left shows the aircraft on a heading of 360°. The heading bug is engaged to the flight director and maintaining 360°. An inbound course of 010° off the number one localizer is the selected course. The cyan **course pointer** and **digital readout** legend informs the pilot that the short-range navigation mode is not engaged to the flight director.

The NAV source annunciator remains in place even though the unreliable condition exists within the system.

- **TO/FROM Indicator** – The TO/FROM indicator is a white



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solid triangle superimposed on the center line of the course pointer. It is positioned at the nose (TO ▲) or tail (FROM ▼) of the helicopter symbol, and moves with the course pointer.

The DU determines whether the helicopter is flying TO or FROM the navigation source when tuned to a VOR.

When deviation from the VOR course is ≤88°, the TO/FROM indicator is positioned at the nose of the aircraft symbol indicating TO the station. When deviation from the VOR course is ≥92°, the TO/FROM indicator is positioned at the tail of the helicopter symbol indicating FROM the station. When the selected NAV source is the FMS, the TO/FROM indicator is driven by the FMS. When deviation from the VOR course is between 88° and 92°, the TO/FROM indicator is unreliable and is removed from display.

A loss of reliable heading information from the AHRS, or a loss of reliable bearing information from the NAV receiver does not display the TO/FROM indicator. In addition, a loss of the TO/FROM status from the FMS when the FMS is selected does not display the TO/FROM indicator.

- **Localizer Miscompare Annunciator** – When a localizer

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miscompare is detected, the LOC annunciator is displayed on the HSI just below the helicopter symbol on the compass card. This alerts the pilot to a localizer miscompare.

The LOC miscompare annunciator has display priority over all scale markings. It toggles between LOC and LOC during the the first six seconds. After six seconds, the LOC shows steadily. The annunciator is removed when a localizer miscompare is no longer detected.

A loss of valid deviation information from the NAV receiver or monitor warning function does not display the LOC annunciator.

- **Bearing Pointers** – Two bearing pointers can be displayed on the

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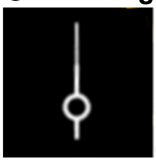
compass arc. When selected, the bearing pointer functions as a radio magnetic indicator (RMI). They are presented on the display by pushing either the BRG○ or BRG◇ bearing select buttons on the display controller. The white (○) bearing pointer is used for copilot side sources. The green (◇) bearing pointer is used for pilot side sources.

The display unit receives bearing information from the on-side and cross-side VOR, ADF, and FMS over the ASCB. VOR (magnetic) and FMS (true) data are heading card referenced (absolute) and ADF data is case referenced (relative). When displaying the magnetic referenced heading card against an FMS, the bearing pointer is compensated for magnetic variation.

- ○ **Bearing Pointer** – The circle bearing pointer is always white. It toggles VOR1 → ADF1 (option) → FMS1 (option) → OFF data, by pushing the BRG○ on the display controller. The active source for the white (○) bearing pointer annunciator is displayed in white on the lower left corner of the PFD.



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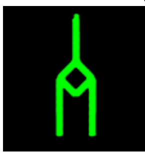
- ◇ **Bearing Pointer** – The diamond bearing pointer is always green. When selected, the diamond bearing pointer toggles VOR2 → ADF2 (option) → FMS2 (option) → OFF data by pushing BRG◇ button on the display controller. The active source for the green (◇) bearing pointer annunciator is displayed in green on the lower left corner of the PFD.



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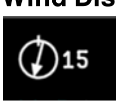
The potential annunciators are: VOR1, VOR2, ADF1, ADF2, ADF, FMS, FMS1, FMS2.

A loss of heading information from the AHRS, or a loss of bearing information from the NAV receiver does not display the absolute (VOR and FMS) bearing pointers.

- **Wind Display** – Aircraft equipped with the FMS shows wind speed and direction information. The wind direction is displayed as a vector enclosed in a miniature compass rose located in the lower right corner of the HSI. Wind speed is displayed adjacent to the vector and is rounded to the nearest one knot. The wind display is not displayed when displayed wind speed reaches zero. The wind display on the PFD is white. When the FMS indicates data as stale, or **no computed data**, the wind display turns amber.



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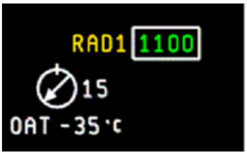
When the FMS data is displayed against a magnetic heading display, it is compensated for magnetic variation. The magnetic variation for correcting the FMS data is the displayed FMS. The parameters on the PFD compass which must be compensated for are desired track, bearing, and drift angle. When FMS is not the displayed source, drift angle compensates for magnetic variation by using the the FMS.

- **Outside Air Temperature (OAT) Readout** – The OAT digital value is displayed in white below the wind display on both the PFDs. The value ranges are ±99 degrees Celsius.



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A loss of valid OAT information from the ADS shows amber dashes (- - -).

- **PFD FMS Map Range Display (Option)** – When MAP has been selected for display by the DC function with the compass display in arc mode, the FMS flight plan can be overlaid on the HSI in a stick format.

ID-143615

A half-range ring is located equal distance between the outer heading/range compass arc and the arc center. The half-range ring is labeled with the correct range value (1/2 of WX range or 1/2 of display control range when WX/TAWS is not displayed). When either cursor is on the PFD, the map range is controlled using the outer set knob of the cursor control device (CCD). Green brackets are placed around the range display to indicate that it is controlled by the CCD. A curl symbol highlighting the outer knob is displayed adjacent to the map range to indicate which set knob can be used to control the range.

When the outer knob of the CCD is utilized to control map range on the PFD, the cursor is removed from the radio tuning area. In addition, the CAS scrolling on the MFD using the inner knob of the CCD is not displayed.

The values of the range readout can be set as, 0.5, 1, 2.5, 5, 10, 25, 50, 100, 200, 300 NM.

When valid range information from the display control function is lost, amber dashes (- - -) replace the range label. However, the half-range ring remains.

NOTE: The values of the range readout for hover format can be set as 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100 NM.

Active Station Identifier

- **TO Waypoint Identifier** – The TO waypoint identifier is defined when the selected NAV source is not connected to the flight director and the readout is cyan. When the selected NAV source is connected to the flight director, the readout is magenta. The waypoint identifier is on the top line, KDVT.

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- **FMS Annunciators** – The FMS status annunciator is displayed below the power index scale and the TO waypoint readout and ETE on the PFD. The possible annunciators are:

  - APP – Approach
  - OFST – Offset
  - MSG – CDU message
  - DR – Dead reckoning
  - DGR – Degrade.

  

  ID-180789

  The OFST and APP annunciators share the same location with APP having priority. The MSG annunciator is displayed below the power index scale and above the TO waypoint identifier (not shown). It is displayed using inverse video for the first six seconds. The DR and DGR annunciators share the same location next to the RNP display. A loss of valid information from the selected NAV does not display the identifier.

- **RNP (Required Navigation Performance) Display** – The RNP shows when the FMS is selected as the primary navigation source. This indicates to the pilot that a two-dot deflection is equal to the RNP value. RNP information is found above the WX and below the ETE information on the left side of the HSI.

  The RNP value readout shows amber dashes (- - -) when there is a loss of valid RNP information from the FMS. The RNP digital value shows XX.X format for values of 10 or greater. The value shows X.XX for values less than 10. The RNP value colors match the FMS lateral deviation colors of magenta or cyan. After the digital value the NM annunciator is displayed.

- **TO Waypoint Distance Readout** – When a VOR/LOC receiver is selected as the primary NAV source and a valid DME station is available, the corresponding DME distance is displayed (88.7 NM) shown in the figure to the left. When the FMS is selected as the primary navigation source, the distance to the next FMS waypoint is displayed. When the FMS is selected, the FMS waypoint identifier toggles reverse video when a waypoint sequencing alert condition is active. When the DME is tuned to a station that is not collocated with the selected VOR, an H is annunciated adjacent to the DME distance to indicate that it is in DME hold mode and is not synchronized with the VOR. The color of the distance readout follows the color of the TO waypoint (such as, 88.7 NM when not coupled to the flight director and 88.7 NM when coupled to the flight director).

  The distance digital readout range is 999 NM. From 0–99.9 NM, the information is rounded to the nearest .1 NM and the resolution is 0.1 NM. For distances greater than 99.9 NM, the information is rounded to the nearest 1 NM and the resolution of the display is 1 NM. The digital readout is annunciated with NM. The loss of valid distance information from the selected NAV source changes the digital readout to amber dashes (- - -).

  The second item of information in the legend is the DME distance from the station. In this example, the helicopter is 88.7 NM from KPHX. DME computes range in nautical miles (NM) from a VORTAC (combined VOR and TACAN stations), localizer/DME facility to the helicopter. The maximum distance of the digital readout is 999 NM. From 0–99.9 NM, distance is rounded to the nearest .1 NM. Distances greater than 99.9 NM are rounded to the nearest 1 NM.

- **EDS (Electronic Display System) DME Distance Output** – The EDS gives the DME distance output on the ASCB for use by the AFCS. EDS outputs the DME distance of the corresponding DME station when the VOR/LOC is selected as the primary navigation source or as the preview navigation source and the preview mode is OFF.

- **Estimated Time En Route (ETE)** – When DME distance is displayed, the estimated time en route to the station is calculated using the DME ground speed. When the FMS distance is displayed, the estimated time en route to the waypoint, as calculated by the FMS, is displayed. In the example at left, the ETE is located below the distance readout and it shows 1+22 ETE. Once again, the color of the ETE readout matches the color of the TO waypoint.

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  For ETE less than one hour, the ETE is displayed as two characters (minutes 22 ETE). For ETE equal to or greater than one hour, the ETE is displayed as hours and minutes (such as, 1+22 ETE or 1+22 ETE). The maximum displayable ETE is 9 hours and 59 minutes (9+59).

  A loss of ETE information from the selected NAV source shows amber dashes in the (- - - ETE) legend.

Preview Mode Operation

When the FMS is the displayed navigation source on the PFD, VOR/ILS course deviation and vertical deviation can be previewed on the compass card formats of the PFD. Previewed NAV source data is selected by the display control function.

- **Lateral Deviation** – When a preview NAV source is selected for display, a course arrow and deviation bar is displayed on the compass card. Turning the course select knob permits selection course for the preview NAV source. The lateral movement of the deviation bar on the preview course arrow is scaled to match that of the lateral deviation pointer for normal VOR/LOC display.

- **Vertical Deviation** – The vertical deviation scale adjacent to the attitude sphere is displayed in the preview mode when the NAV receiver is tuned to a localizer frequency. Any valid vertical deviation data is displayed on the left side of the scale.

  When no preview navigation source has been selected and the preview vertical deviation from the FMS is valid, the vertical deviation is displayed on the left side of the scale.

- **Previewed Source Annunciator** – A source annunciator of the previewed NAV is displayed to the right of the active navigation source annunciator. When no preview navigation source has been selected, the VGP annunciator is displayed to the right of the active navigation source annunciator when either of the following conditions are met:

  — The preview vertical deviation from the FMS is valid

  — The flight director indicates that VGP is armed in vertical mode.

  The possible NAV source annunciators for preview are: VOR1, VOR2, LOC1, LOC2, and VGP.

  When the preview navigation source is VOR1 or VOR2, the loss of valid lateral deviation information from the NAV receiver and the loss of valid heading information from the AHRS removes the previewed course deviation bar.

  When the preview navigation source is LOC1 or LOC2, the loss of valid lateral deviation information from the NAV receiver removes the previewed course deviation bar.

- **Preview Course Information** – When a preview NAV source is selected, a preview course digital readout is displayed below the preview source annunciator. The preview course is controlled using the course select knob on the remote instrument control (RIC).

  The preview course information is left blank when the preview source annunciator is VGP.

  A loss of valid heading information from the AHRS, or loss of valid information from the display control function removes the preview course pointer. The course digital readout is replaced with amber dashes (- - -).

- **Preview NAV Source Auto Transition** – When a preview navigation source is displayed on the PFD and the flight director capture criteria for that navigation source is met, the following occurs:

  — The preview course pointer is removed from the display

  — The PFD primary navigation source switches to the source that was previously displayed on the preview course pointer.

PFD Weather Radar Display (Option)

- Weather radar returns can be overlaid on the HSI with or without FMS map display. The pilot accomplishes this by using the DC function when the compass display is in arc mode and weather returns have been selected.

  PFD weather radar (WX) annunciators are displayed below the RNP display in the lower left corner of the HSI. This happens when the radar returns are selected for display or when weight is on wheels and a transmit mode is active (all weather radar modes except OFF and standby). For a complete description of the weather radar system, refer to Section 16, PRIMUS EPIC 660/700/701 Digital Weather Radar System.

WEATHER/TAWS

The display of weather and terrain scans across the arc mode are selected on the display controller using the **WX/TERR** button.

- **WX/TERR (Weather Radar/Terrain Awareness Warning System) Control Button** – Pushing the **WX/TERR** button toggles the HSI display in the following sequence:

  ☞ WX/TAWS DATA OFF ☞ ARC + WX ☞ ARC + TERR

  Pushing the **WX/TERR** button selects the arc mode for the HSI.

  When WX or TAWS (EGPWS) is not installed, selection of the corresponding item is removed from the sequence of the **WX/TERR** button on the display controller. NO WX/TAWS INSTALL is displayed for six seconds when the **WX/TERR** button is pushed and weather radar or TAWS is not installed in the aircraft.

  An example of weather displayed on the HSI in the arc mode is shown in Figure 5-20. Weather is described in detail in Section 16, PRIMUS EPIC 660/700/701 Digital Weather Radar System.

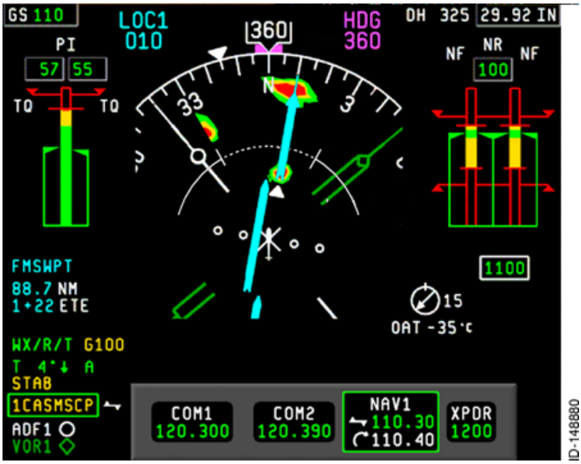


Figure 5-20
Weather on the PFD

An example of TAWS is displayed on the HSI in the arc mode as shown in Figure 5-21. Refer to Section 19, Terrain Alert Warning System (TAWS) for a complete description of the TAWS annunciators.

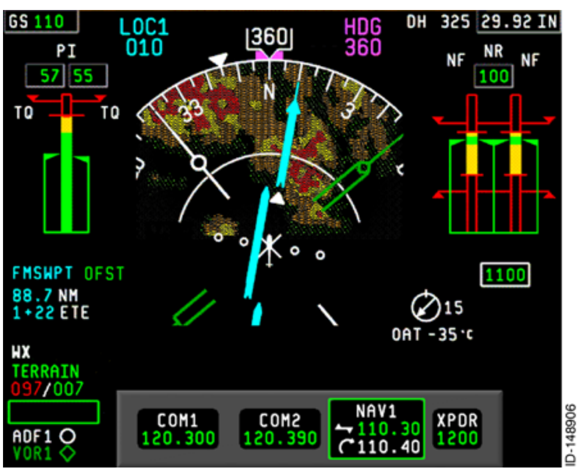


Figure 5-21
TAWS Displayed on the PFD

TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS)

When the TCAS detects an intruding aircraft that is considered potentially hazardous, aural and visual traffic advisory (TA) alerts are displayed. **TRAFFIC** is displayed in the upper left corner of the attitude sphere, as shown in Figure 5-22. The **TRAFFIC** display flashes for the first six seconds and then shows steadily.

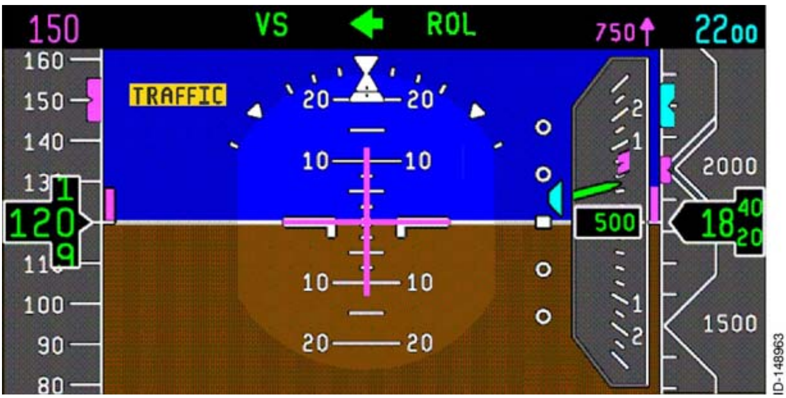


Figure 5-22
TA Advisory Message on PFD

The following TCAS status annunciators are displayed in the upper left corner of the attitude sphere:

- When TCAS indicates a functional test, a **TCAS TEST** is displayed.
- When TCAS is valid or in a functional test and TCAS indicates standby, a **TCAS OFF** is displayed.
- When the following conditions are present, a **TCAS FAIL** annunciator is displayed:
  - — TCAS bus fails
  - — TCAS indicates TCAS system failure
  - — TCAS control indicates failure or no data.

The TCAS status annunciators (when installed) share the same location as **TRAFFIC** annunciator using the following priority from highest to lowest **TCAS TEST**, **TCAS OFF**, **TCAS FAIL**, **TRAFFIC**.

When the TCAS is invalid, the **TRAFFIC** annunciator is not displayed and the **TCAS FAIL** annunciator is displayed.

For a complete description of the operation, control, and display of TCAS information, refer to Section 18, Traffic Alert and Collision Avoidance System (TCAS).

FLIGHT PLAN (OPTION)

The display of the FMS flight plan that overlays the other HSI data is selected on the display controller using the **MAP** button.

- **MAP Display Control Button** – Pushing the **MAP** button toggles

the FMS route-of-flight map display ON and OFF (when installed). When the HSI is not in arc mode when the **MAP** button is pushed, the arc mode shows. The design of the flight plan layout is described in Section 6, Multifunction Display. An example of a flight plan on the HSI in the arc mode is shown in Figure 5-23.

  Toggling the **MAP** button switches the map display between showing and not showing the FMS flight plan.

  When the FMS is not available, the **MAP** button acts like the **HSI** button.

Figure 5-23
Flight Plan Displayed on the PFD

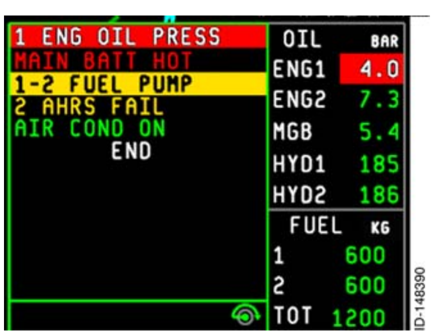
Engine, MGB, HYD System Pressures and Fuel Quantity

The CAS window, engine, MGB, Hyd System and fuel information, as shown in Figure 5-24, are displayed when a DU reversion has taken place. In this case, the MFD has reverted to the PFD display. The secondary engine indicators are displayed on the PFD when the CAS message display is shown below the compass rose on the HSI. They consist of engine pressures and fuel quantity.

Figure 5-24 shows the location of the pertinent MFD data relative to the CAS message display (bottom quarter of the HSI portion of the PFD). The oil pressures are displayed on the top half of the display and fuel quantities are shown on the bottom half of the display.

Figure 5-24
Engine, MGB, Hyd System Pressures and Fuel Quantity

- **Engine, MGB, Hyd System Pressures and Fuel Quantity** – The secondary engine indicators include engine, MGB, Hyd system pressures and fuel quantity.



- **Oil Pressures** – Oil pressures are displayed in descending order as

ENG1, ENG2, MGB (main gear box), HYD1, and HYD2. The digital readouts are green when the value is in the normal range (such as, ENG1 7.3). Digital readout values display in amber inverse video when they are in the caution range (such as, ENG1 4.7), or red inverse video when they are in the warning range (such as, ENG1 4.0). The complete description of engine readouts are given in Section 6, Multifunction Display.

- **Fuel Quantity Indicators** – The fuel quantity indicator consists of

a FUEL display and digital quantity readouts in three windows that represent the left tank (1), right tank (2), and total fuel (TOT). The fuel quantity indicator is calibrated to measure fuel quantity in pounds LB or kilograms KG as desired. Selection between the two is made using the configuration submenu of the MFD. The digital fuel quantity is displayed in green.

Crew Alert System (CAS) Messages

The pilot is alerted to WARNING or CAUTION CAS messages when the MASTER WARNING LIGHT or MASTER CAUTION LIGHT begins flashing from the position above the PFD on either side of the the instrument panel. Flashing of one of these lights is intended to direct the attention of the pilot to the CAS window.

There are four CAS message priority levels with color codes to reflect the priority of each. The color coded messages are displayed in order of descending priority listed in Table 5-13.

Table 5-13
CAS Message Priority Levels and Color Code

Message Type By Color	Priority	Acknowledgement
WARNING	Highest	Pilot
CAUTION	Second	Pilot
ADVISORY	Third	Automatic After 5 Seconds
Status	Fourth	Automatic After 5 Seconds
End	Last	Not Applicable

During a display reversion with the composite display shown on the PFD, the following display exceptions exist:

- Hover mode indications are not available on the composite display format.
- The CAS window can overlay a portion of the compass rose in the HSI.
- The display unit test vector annunciator is available in the CAS window.

During a reversion, the indications on the PFD consist of the following:

- CAS messages
- Engine oil pressure

- Main gearbox oil pressure
- Hydraulic oil pressure
- Fuel quantity.

CAS MESSAGES

When an automatic or a manual reversion occurs, a composite is generated of the CAS window on the PFD. The CAS message window displays color coded text messages that describe system status.

A maximum of 12 messages can be displayed simultaneously. Each CAS message can be composed of up to 18 characters.

The CAS window is normally viewed from the lower right corner of the MFD. However, during a reversion, a CAS window is generated at the bottom center of the HSI segment of the PFD, as shown in Figure 5-25.

Figure 5-25
CAS Message Window - Reversion Conditions (Typical)

An example of PFD CAS message formats are shown in Figure 5-26. CAS messages can be displayed in the full compass mode.

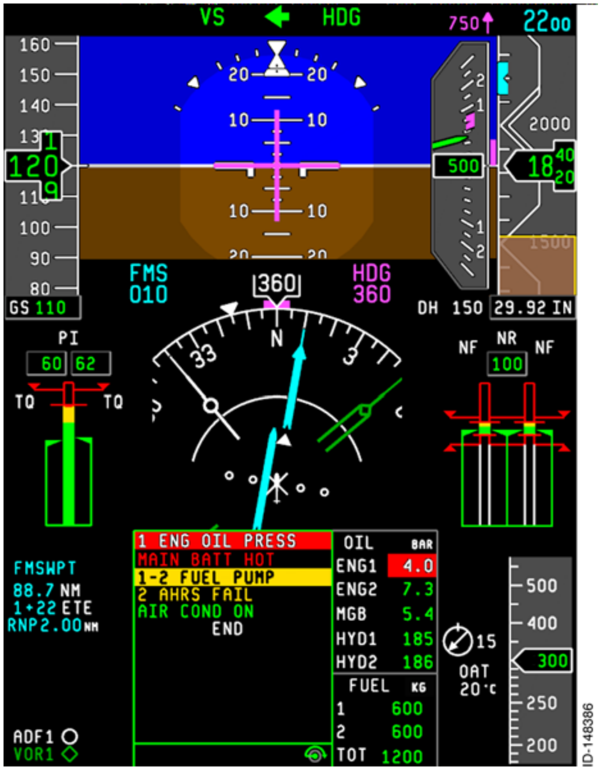


Figure 5-26
PFD EICAS Reversion Mode

Primary Engine Instruments

Essential engine information and rotor rpm, as shown in Figure 5-27, is continuously displayed on the power index (PI) and the triple tachometer (tritach).

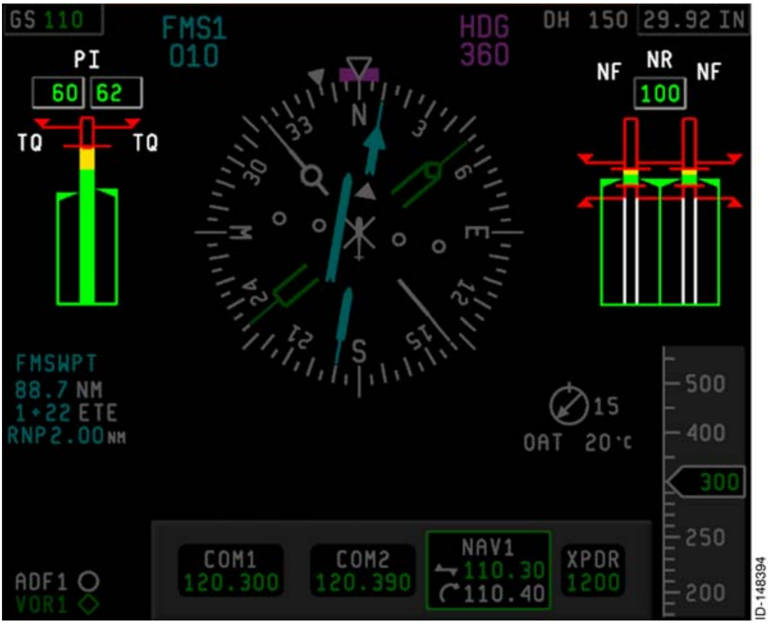
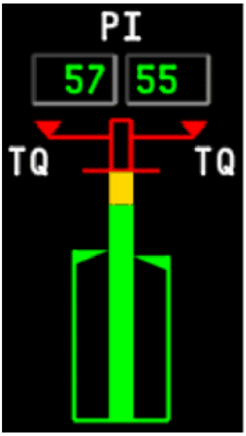


Figure 5-27
Power Index (PI) Gauge and Triple Tachometer (Tritach) Position (Full Compass Mode)

The PI and tritach are elements of the vehicle monitoring system (VMS) that continuously shows essential engine information. It consists of graphics that show the general condition of the engines at a glance. Areas of operational limitations are clearly defined using the color codes described in the following paragraphs.

POWER INDEX (PI)



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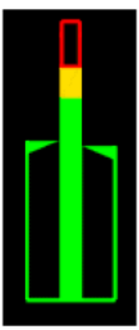
The figure at left is the PI gauge. It is a single bar gauge positioned left of the HSI identified by the **PI** legend displayed above the digital readout windows. The gauge shows the actual power delivered by the engines, in percent, with respect to the power available.

The legend shown on top of the analogue scale (TQ, ITT or NG) represents the engine parameter that is limiting the power and is independent for each engine. For example, one engine can be TQ limited and the other can be ITT limited.

The analogue scale of the PI gauge is divided into four colored segments. Each segment is listed in Table 5-14.

- **PI Pointers** – Shown at left are the two triangular pointers that travel vertically along the outside of the bar gauge. The pointer on the left side of the bar gauge represents the condition of the left engine (engine number one). The pointer on the right side of the bar gauge represents the condition of the right engine (engine number two).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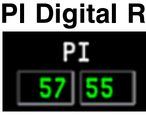
These pointers indicate the amount of power delivered by an engine while the color (the same as the scale in which the pointer is positioned) represents the engine power rating. For example, green is a continuous rating, amber is a time limted rating and red is an exceedance of an approved rating.

The behavior is designed to visually alert the pilot that a time limited power condition has been achieved. Therefore, attention is required to avoid power exceedance.

The previous illustration shows a steady state condition of both engines in the normal (continuous) operating range.

- **PI Digital Readout** – Positioned above the bar gauge is a digital readout for both engines supplying the exact numeric value reflected by the bar graph display.



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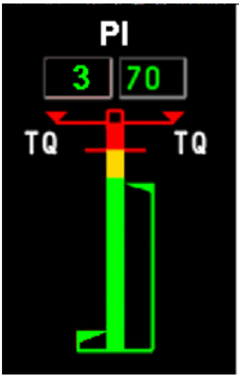
The digital readout is displayed in green numbers when the engine is operating in the **normal (continuous) operating range**. The digital readout is displayed in amber when the engine is operating in the **cautionary (time limited) range**. The digital readout is displayed in red when the engine is operating outside the **approved operating range**.

In the example below, the number one engine is operating in the **normal range** with a PI of 3% torque and the number two engine is operating in the **normal range** at 70% torque.



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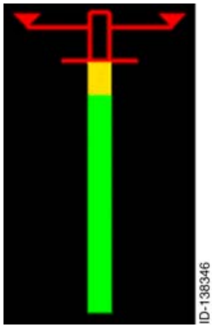
The example of the PI gauge at left shows the equivalent torque available from the number one engine is decreasing through **3%** and **AEO** (all engines operating) mode is active.

When TQ, ITT, NG, or pressure altitude data from the ADS is not available for an engine, amber dashes display (**- - -**) on the digital readout for the effected engine and the pointer is removed from the scale. In addition, the power index relies on pressure altitude and uses the same air data source for computations with priority to the pilot ADS. When the ADS2 test is initiated, the PI for each engine shows amber dashes (**- - -**).

- **PI Maximum/Transient Limit Indicators** – Shown at left, on the bar gauge of the PI is the is the maximum limit redline indicator and the maximum transient limit indicator.



The maximum limit redline is shorter than the maximum transient limit indicator at the top of the display without associated triangles positioned at the upper limit of the amber cautionary range. Operation above the normal maximum limit redline is permissible for brief transient periods when transient limitations have been defined for inadvertent exceedance of the maximum limit redline.

The transient limit indicator is identified by the two red triangles ( ) positioned at either end of a longer line that crosses the bar gauge at a specified point.

Table 5-14 lists color usage in the PI gauge and tritach.

Table 5-14
Power Index and Triple Tachometer Gauge Color Code

Color	Indication
Green	**Normal Operating Range** • Indicates normal operating conditions exist during ground or flight operations. • Green lines parallel to the bar gauge with ends at specific range limits are comparable to the green arcs on round dial analog instruments.
Amber	**Cautionary Range** • Indicates a condition exists during ground or flight operations where limited operations are permissible but caution is required. • Amber lines parallel to the bar gauge with ends at specified range limits are comparable to the amber arcs on round dial analog instruments.

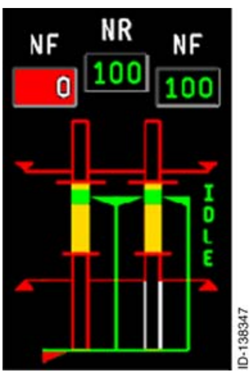
Table 5-14 (cont)
Power Index and Triple Tachometer Gauge Color Code

Color	Indication
Red	**Emergency Range** • Red displays indicate an operating limitation has been **exceeded** and **immediate** pilot action required. • Red **lines** parallel to the bar gauge with ends at specified range limits are comparable to the arcs on round dial analog instruments.
Red Lines	• Red **lines** are placed at the limit of a normal operating range. • They define normal maximum limits and certain conditional limits. • Multiple red **lines** can be displayed one at a time. • Multiple red **lines** have distinguishing features, such as one solid line and one dashed line, or lines of different lengths. • Comparable to the red **radial lines** applied to round dial analog instruments.
	• Transient range markings indicate engines and main transmission restricted ranges during dynamic conditions of operation such as start-up and acceleration that are of concern for short periods of time . • They are distinct from the steady state limits.
Red Triangle	• Red **triangle** at each end of a red **line** indicate an in-flight transient limit above a normal maximum limit red **line**. • A red **dot** indicates a transient condition during engine start-up.
Transient Range	The range, represented by a hollow red **box** at the top of the bar gauge, where a system can be operated above redline in specific conditions and for specific durations.

WARNINGS

1. **OPERATION OF A MONITORED SYSTEM ABOVE THE REDLINE AT TOP OF THE CAUTIONARY RANGE INDICATES AN EMERGENCY EXISTS REQUIRING IMMEDIATE ACTION FROM THE PILOT.**
2. **OPERATION ABOVE THE REDLINE IS PERMISSIBLE FOR BRIEF TRANSIENT PERIODS BUT ONLY IN ACCORDANCE WITH TRANSIENT LIMITATIONS DEFINED IN THE PILOT'S OPERATING HANDBOOK.**

TRIPLE TACHOMETER (TRITACH)

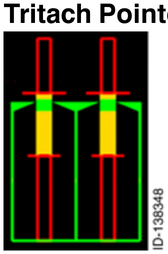


The tritach is displayed directly to the right of the HSI. It is composed of three tachometers that are represented as bar gauges combined together in one graphic display. A digital readout is positioned above the bar gauges. The tritach continuously monitors power turbine speed (NF) for both the number one and number two engine and the main rotor speed (NR).

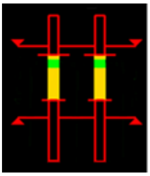
The digital readouts are for both the NR and NF values. The readouts are analog. The digital readout shows green with engines and main rotor operating within **normal operating ranges**. The digital readout shows **amber inverse video** or **red inverse video** when operations exceed into the amber or red range.

As with the **PI** described previously, the bar gauges of the tritach are divided into the color segments listed in Table 5-14.

- **Tritach Pointers** – Three triangular pointers travel vertically along the sides of the two bar gauges. The pointer colors match the zone to which they are pointing (such as, when they are pointing in the **amber zone**, the pointers are amber). The pointer on the left side of the left most bar gauge indicates **NF** of the number one engine. The pointer on the right side of the right most bar gauge indicates **NF** of the number two engine. The pointer in the center between the two bar gauges indicates **NR**.



- **Tritach Maximum/Transient Limit Indicators** – Shown at left are the maximum limit redline indicators and the transient limit indicators on the bar gauge of the tritach. As with the PI gauge described previously, the normal maximum limit redline are the shorter lines positioned horizontally on the bar gauge, one positioned at the upper limit of the amber cautionary range and a shorter one positioned at the lower limit of the amber cautionary range.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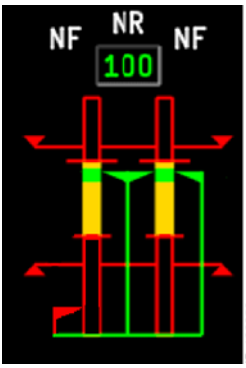
The transient limit indicator is identified by two red triangles ( ) positioned on a longer line that crosses the two bar gauges at specified points. The position of the indicator on the bar gauge is determined by the system being monitored and the transient time limit defined for that system. The emergency range portions of the bar gauges are outlined in red beginning at the redlines, as shown above.



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The example at left shows an rpm (revolutions per minute) split between the number one engine NF tachometer and the NR tachometer in the center of the gauge. This needle split indicates the number one engine has failed.

The NF tach of each engine continuously compares itself with the rotor tach. In the event of engine failure, the power turbine begins to decelerate reducing NF rpm of the failed engine. A mechanical freewheel assembly decouples the failed engine from the power train enabling the operating engine to continue powering the main rotor.

The NF tach continues to compare its rpm to the rpm of the main rotor. As NF decelerates, the failed engine pointer on the tritach moves from the green normal operating band through the amber cautionary range band and low side redline in the direction of the bottom of the bar gauge. In the example at left above, the number one engine pointer has exceeded the normal maximum limit redline and the transient limit indicator into the red empty area of the gauge.

The FAIL annunciator, adjacent to the outside of either bar gauge on the tritach alerts the pilot to a failure of the respective tachometer. It is **not** an indication of engine failure.

WARNINGS

1. **OPERATION OF THE MONITORED SYSTEM BELOW THE REDLINE AT THE BOTTOM OF THE NORMAL OPERATING RANGE INDICATES AN EMERGENCY CONDITION REQUIRING IMMEDIATE ACTION FROM THE PILOT.**

2. **OPERATION OF A MONITORED SYSTEM ABOVE THE REDLINE AT TOP OF THE CAUTIONARY RANGE INDICATES AN EMERGENCY CONDITION EXISTS REQUIRING IMMEDIATE ACTION FROM THE PILOT.**

3. **OPERATION ABOVE THE REDLINE IS PERMISSIBLE FOR BRIEF TRANSIENT PERIODS BUT ONLY IN ACCORDANCE WITH TRANSIENT LIMITATIONS DEFINED IN THE PILOT'S OPERATING HANDBOOK.**

Engine Ratings (AEO, OEI, OEI TNG, Autorotation) and Color Codes

The aircraft operates in one of four different flight conditions. The PFD and MFD continuously display information concerning the existing condition. For each condition, the engines have been assigned a different rating.

The following description details the engine rating information displayed on the PFD. The four engine ratings are:

- All engines operating (AEO)
- One engine inoperative (OEI)
- One engine inoperative – training (OEI TNG)
- Autorotation.

Each condition has three operating ranges.

- The green range is the **normal operating range**. The engines can operate in the normal operating range for an unlimited time.
- The amber range is the **cautionary range** in which engine operation is permitted for a limited time.
- The redline begins the **emergency range**. Engine operation is prohibited above the redline except for brief transient periods defined in the pilot's operating handbook.

Transient limits have been defined for certain operating ranges that permit for briefly exceeding established operating limitations. For specific engine operating limitations and transient limits, reference Agusta AB139 Rotorcraft Flight Manual (RFM), Limitations section.

- **All Engines Operating (AEO) Mode** – AEO refers to multiengine operation, a condition in which both engines are fully operational with **PI** and the tritach within normal operating ranges.

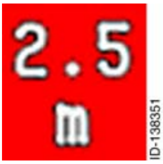
  AEO is the default mode during initial power-up when on the ground. The **PI** and tritach on the PFD display AEO mode **PI** and the tritach conditions.

  The NG, ITT, TQ, and tritach display AEO mode on the MFD main page at startup as well.

- **One Engine Inoperative (OEI) Mode** – OEI refers to single engine operations, a condition when one engine is not operating or generating sufficient power to sustain flight. When an engine fails or is not generating power, the **PI** and the tritach automatically revert to displaying OEI mode.

  There are two separate classifications of events or event classes in the OEI mode. When an engine fails, OEI mode activates automatically displaying the **PI** and the tritach in one or the other event classes described in the following paragraphs:

- **2.5 Minute Event** – The pilot is alerted to the existence of an OEI, 2.5-minute event by displaying the 2.5m legend over the operating engine scale and the presence of the event class legend at left.



  An active OEI event is based on the the following ITT, NG, and TQ parameters on the remaining operational engine:

  — ITT > 775°C or 105.4%, or
  — NG > 102.4%, or
  — TQ > 140%.

  A steady **2.5m** over the operating engine scale indicates an OEI, 2.5m excursion is detected. A blinking **2.5m** over the operating engine scale indicates time remaining for the OEI 2.5m event class is within 10 seconds of expiration. A steady **2.5m** indicates that the time for the OEI 2.5m event class has expired.

When bus communication to the electronic engine controller (EEC) is lost, the **EEC DATA** CAS message is displayed and the specific OEI event is determined using ITT, NG, and TQ parameters from the operating engine. The MAU does the following:

- Determines the active state of each specific OEI event class based on ITT, NG, and TQ parameters of the working engine.
- Otherwise, it maintains an internal (not visible) counter for 2.5-minute OEI class.
  - On the PFD and MFD, the **2.5m** legend is displayed when any engine limit defined previously is exceeded for more than five seconds in 2.5-minute class.
  - On the PFD and MFD, the **2.5m** legend blinks when any engine limit described previously is exceeded for more than 140 seconds and becomes steady after 150 seconds.
  - On the PFD and MFD, when the active counter reaches the 150 seconds in the 2.5-minute class OEI rating, the **2.5m** legend is displayed.
  - The counter stops counting and the **2.5m** legend is removed once its associated event class becomes inactive.

When an electronic engine controller (EEC) reverts to manual mode due to internal failure or pilot action, the **MAN** annunciator is displayed. It is located on the effected engine side of the PI scale. When the message first comes on, it flashes for six seconds before displaying steadily.

- **Continuous MCP** - MCP is the maximum torque available, reflected on the **PI** gauge of the operating engine, for continuous single engine operations. When a continuous MCP OEI event class is activated, an **OEI** legend is vertically displayed on the upper part alongside the PI scale of the failed engine.

When OEI mode is active, the **autorotation/OEI** V_{NE} limit is displayed as a barber pole on the airspeed tape.

WARNING

OEI OPERATIONS, OTHER THAN OEI TNG OPERATIONS, CONSTITUTE AN EMERGENCY CONDITION REQUIRING APPROPRIATE ACTION FROM THE PILOT.

- **OEI Training (OEI TNG) Mode** – When OEI TNG mode is selected, the following conditions are met and displayed on the PFD.

— PI and tritach scales indicate derated engine power limits

— The TNG legend is displayed vertically alongside of the PI scale of the engine that is no longer operating

— The $\mathbf{V_{NE}}$ barber pole is displayed on the airspeed tape.

- **Autorotation Mode** – When autorotation/OEI TNG mode is selected, the following conditions are met and presented on the PFD.

— The tritach scale shows autorotation NR limits

— The NR speed is the only parameter that has visual and aural warning trip points changed to reflect power-off limits

— Autorotation/OEI $\mathbf{V_{NE}}$ barber pole is displayed on the airspeed tape.

Primary Flight Display (PFD) Radio Tuning

Radio tuning information is displayed in the bottom center of the HSI. Displaying tuning information on the PFD eases COM/NAV radio management. The currently tuned frequency for each radio is displayed on the PFD. The exception is when a frequency box has been made active to enable frequency changes, both the active and the preset frequencies are visible, as shown in Figures 5-28 and 5-29.

Figure 5-28
NAV/COM Radio and Transponder Controls on the HSI Segment of the PFD With Active Frequency Box

Using the CCD joystick and set knob, the pilot is able to tune the following on the PFD:

- COM1 radio
- COM2 radio
- NAV radio for the selected NAV source that is displayed on the PFD
- Transponder (XPDR) code
- The transponder code can be input from either PFD.

FREQUENCY BOXES

The PFD presents positions for tuning the XPDR code and NAV/COM frequencies, as shown in Figure 5-29.

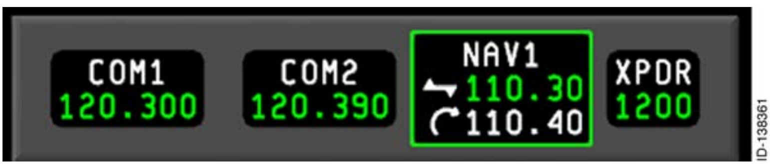
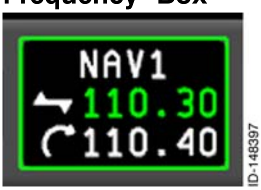


Figure 5-29
NAV/COM Radio Control Box - No Active Frequency Box

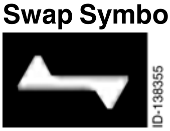
- **Frequency Box** – The CCD is used to change NAV/COM frequencies and the XPDR code on the PFD. A frequency box becomes active when the pilot positions the cursor over the desired frequency box. To indicate that a frequency box has been selected for tuning, all the items in the box are displayed using large letters and numbers or fonts.



The first item contained in a frequency box is the identifier displayed using white fonts. The example previously shows the **NAV1** frequency box.

Immediately below the identifier is the active frequency position. The **active frequency** is always displayed in green. In this instance, the active frequency in **NAV1** is **110.30**.

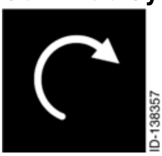
- **Swap Symbol** – When the swap symbol is visible next to the active frequency in the frequency box. It alerts the pilot that the active frequency can be replaced with the white **preset frequency** positioned below it. This process of replacing one frequency with the other in the frequency box is referred to as swapping.



Swapping frequencies makes the old preset frequency the new active frequency. Simultaneously, the old active frequency is positioned as the preset frequency, placing it in a standby condition where it can change or be called up again.

In this example, 110.30 is in the active frequency position and can be replaced by or swapped with 110.40 that is preset in the preset frequency box.

- **Set Knob Symbol** – The set knob symbol prompts the pilot to use the **SET** knob on the CCD to change the frequency highlighted by the cursor.



- **Green Cursor Box** – The green cursor box is positioned to highlight the function using the CCD. Moving the joystick left or right shifts the cursor box between the COM and NAV radios.

Turning the larger knurled knob clockwise increases and counterclockwise decreases the whole number component of radio frequencies.

The smaller knob segment controls the decimal number component of frequency ranges when selecting a radio frequency.

Pushing the **ENTER** button on the CCD swaps the current and preset frequencies for the radio.

Radio Altitude Display

The radio altitude tape, as shown in Figure 5-30, is located in the bottom right hand corner of the PFD immediately below the tritach. The radio altitude display is for altitudes less than 1000 ft or when radar height (RHT) mode is engaged. When RHT is not engaged, the radio altitude tape is not displayed when indicated altitude ascends past 1100 feet. When the aircraft descends below indicated altitude of 1100 feet, the radio altitude tape reappears.

When the radio altitude is in use, the lower portion of the altitude tape functions as a low altitude awareness display. This display alerts the pilot any time the aircraft is being operated within 550 ft AGL.

When the radio altitude test is active, a **TEST** annunciator is displayed on the radio altitude tape.

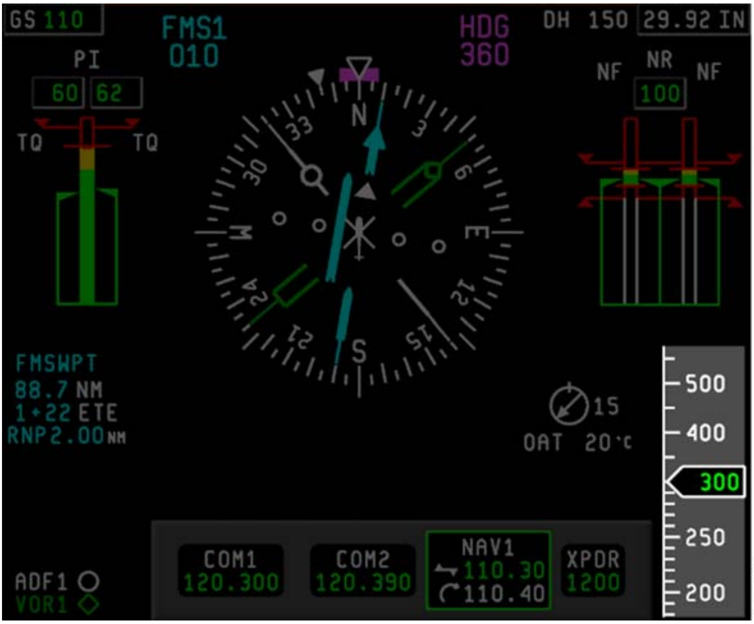
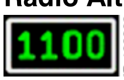


Figure 5-30
Radio Altitude Position (Full Compass Mode)

- **Radio Altitude Digital Readout** – A green digital readout for radio altitude is displayed for altitudes less then 2500 ft. When the radio altitude tape is displayed, the digital readout is incorporated into the tape pointer. When the tape is not present, the digital readout is displayed below the tritach display.

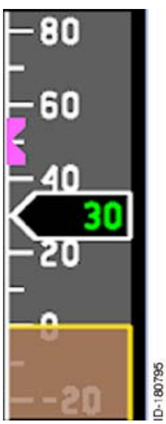


The digital readout is divided into 1-foot increments below +250 ft AGL. Above that, increments are at 10-foot intervals from +250 to +2500 ft AGL and are rounded to the nearest 10 ft. The radio altitude information is not displayed above 2500 ft AGL.

- **Low Altitude Awareness Display** – The low altitude awareness display is an amber line that crosses the altitude tape horizontally. The amber line is the leading edge of an area of brown shading that advances or recedes vertically along the altitude tape with changes in absolute altitude below 550 ft AGL. The low altitude awareness operates the same as the previously described altitude tape.

- **Radio Altitude Reference Bug and Readout** – The radio altitude reference bug is displayed when the flight director RHT mode has been is selected. The bug is a magenta rectangle with a triangular notch, positioned along the right edge of the radio altitude tape corresponding to the radio altitude reference digital readout. When the radio altitude target is off scale, the direction that it is off is indicated.

  The reference digital readout and the bug are not displayed in either of the following circumstances:



— Loss of valid radio altitude information from each MAU
— Loss of valid radio altitude reference information from the priority flight director.

- **Radio Altitude Source Selection** – The PFD selects the source for the radio altitude data. Each PFD shows radio altitude data from the on-side MAU when that data is valid. When the on-side radio altitude data is invalid, the radio altitude data from the off-side MAU is displayed.

  When one radio altitude is installed, it is wired to both MAUs. When two radio altimeters are installed, each is wired to the on-side MAU.

- **Radio Altitude Source Annunciator** – When two radio altimeters are installed and a PFD is displaying data from the off-side radio altitude sensor, the sensor is annunciated as either **RAD1** or **RAD2**.

- **Radio Altitude Test** – During radio altitude test, the radio altitude is displayed regardless of validity.

- **Radio Altitude Miscompare** – When a radio altitude miscompare

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is detected by the EDS monitoring software, a **RAD2** to **RAD** to **RAD2** annunciator flashes for the first 5 seconds, and after that shows **RAD** steadily on top of the radio altitude scale. The annunciator does not display once the miscompare is no longer detected.

  The miscompare function is performed when there are one or two radio altimeters installed. When one radio altitude is installed, the miscompare function compares the same data from the two MAUs.

  When radio altitude information is lost, a **RAD** annunciator replaces the radio altitude digital readout in the center of the altitude tape.

  During a radio altitude test display, the radio altitude display is reliable.

WARNING

THE RADIO ALTITUDE MEASURES ABSOLUTE ALTITUDE ABOVE TERRAIN DIRECTLY BENEATH THE HELICOPTER. IT DOES NOT MEASURE ABSOLUTE ALTITUDE ABOVE TERRAIN IN FRONT OF THE HELICOPTER.

PRIMARY FLIGHT DISPLAY (PFD) FAILURES

The pilot is alerted to system and component failures by annunciators, as shown in Figure 5-31.

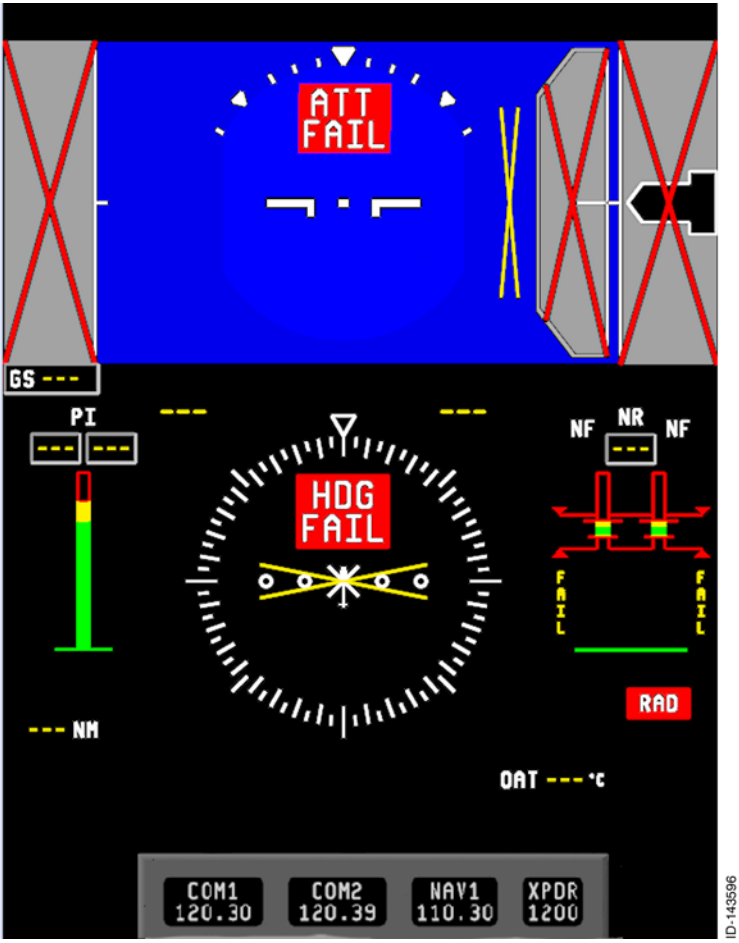


Figure 5-31
Primary Flight Display - Failure Annunciators

6. Multifunction Display (MFD)

INTRODUCTION

The MFD shows the power plant, systems, and navigation information while supplying a means to plan and execute automated flight.

The MFD is segmented into a number of windows, shown in Figure 6-1. The content of the upper window is controlled using the cursor control device (CCD) and the menu bar displayed at the top of the MFD.

A dedicated dimming knob controls the light intensity of the MFD. The display cannot be dimmed to such a dark condition that it becomes unreadable in nighttime ambient light conditions.

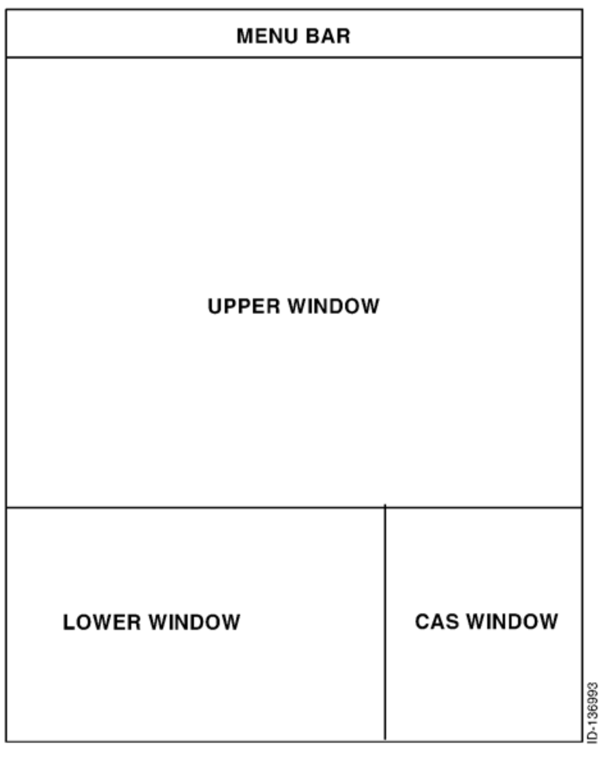


Figure 6-1
MFD Segment Diagram

- **Upper Window** - The upper window can be configured to display the following formats:
  - — Pwr Plant (Main page)
  - — System
    - Electrical
    - Hydraulic
    - AFCS
    - Video Display (option)
    - Configuration (on ground)
    - Maintenance (on ground)
  - — Map
  - — Plan.

- **Lower Window** - The lower window shows secondary engine and system data. When the **main** format is selected for the upper window, the lower window is combined with the upper window to give a large window for display of engine and system data.

- **CAS Window** - The CAS window is used to show messages from the crew alert system (CAS). This window always shows while airborne or on the ground.

  When **maintenance** or **configuration** formats are selected, all three MFD windows merge to give a full screen display for these functions.

The Main (or Pwr Plant) page, as shown in Figure 6-2, is the default format for the power-up MFD display.

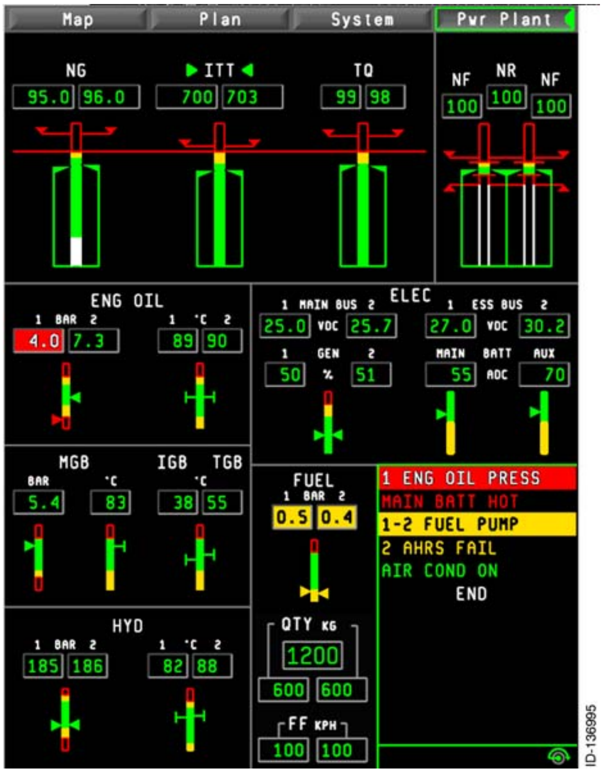


Figure 6-2
Multifunction Display Main Page

TITLE MENU BUTTONS

Four menu buttons, as shown in Figure 6-3, are always displayed across the top of the MFD page. The four buttons in the menu are labeled **Map, Plan, System,** and **Pwr Plant**. Each menu button has subordinate drop-down submenus. The submenus permit the cockpit crew to select and control the various MFD synoptic pages. Some synoptics menu buttons are used in combination.

Figure 6-3
Title Menu Buttons (Pwr Plant Selected)

A green cursor surrounds the selected main menu button and is used to select the menu buttons. The cursor can be moved left and right using the corresponding joystick direction on the CCD. The cursor is displayed with a chevron on either the left or right side. This chevron is used to annunciate which CCD is in control of the cursor. The right chevron indicates pilot control, and the left chevron indicates copilot control.

In the three display configuration, one CCD is in control of the MFD at any time. When the pilot CCD controls the MFD and the copilot selects the MFD using the copilot display select button, the pilot cursor moves to that PFD.

In the four display configuration, there is an MFD dedicated to each pilot. Selection of the MFD by either pilot has no effect on the other cursor location.

Pushing the CCD **ENTER** button when one of the menu bar buttons is highlighted, switches the main MFD window to display the highlighted format.

The electronic display system (EDS) synchronizes the cursor function to enable rapid display of the relevant MFD page using a single button push. The automatic cursor synchronization is triggered by an alert from the following:

- TAWS system
- Traffic advisory from the TCAS system.

When a TAWS alert is indicated by the TAWS system, the cursor moves to the MFD and is located on the **Map** menu button.

When a TCAS traffic advisory is indicated by the TCAS system, the cursor moves to the MFD and is located on the **Map** menu button.

When one of the CAS messages triggers the cursor synchronization function to display, the cursor moves to the MFD and is located on the **Pwr Plant** menu button.

When a CAS miscompare event occurs, the cursor moves to the PFD and is located on the CAS miscompare annunciator. When a cursor synchronization event occurs, subsequent higher priority events synchronize the cursor as appropriate for the higher priority event.

When a cursor synchronization event occurs, subsequent lower priority synchronization events are not displayed for a period of 10 seconds. Subsequent pushes of the **ENTER** button on the pilot CCD shows the page corresponding to the button on which the cursor was relocated. In a three display configuration, when the copilot CCD was on the MFD, activation of the synchronization function moves the copilot cursor to that PFD. This permits the pilot CCD to control the MFD. Pushing the **Right** display select button followed by the **ENTER** button permits the copilot to select the main page using the CCD.

The menu buttons are drawn to create the illusion of a three dimensional button. The currently selected display format shows the corresponding menu button in a pushed position.

When a menu button has been highlighted, the corresponding drop-down menu is displayed by moving the CCD joystick down. Moving the CCD joystick up and down selects particular items on the drop-down menu. The menus can be retracted by any of the following actions:

- Toggling up when the top menu item is selected
- Toggling left or right when a menu item is selected that does not have a submenu
- Selecting a display select button on the CCD
- Selecting the **ENTER** button on the CCD when a menu item is highlighted results in a display format change.

Details of each of the drop-down menus are given in the following sections in conjunction with the description of the corresponding display format.

MFD menu buttons, as shown in Figure 6-3, share the following characteristics:

- One menu button is active at a time

- A submenu is activated by positioning the cursor over the menu button with the cursor control and pushing the **ENTER** button on the CCD

- Activation of the menu button reveals the associated pull-down or pop-up control submenu

- When a submenu is currently being displayed, pushing the **ENTER** button on the CCD deactivates or closes it.

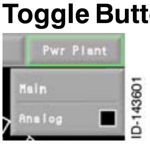
Submenu Button Types

The submenu buttons are located on the menu control functions on the MFD display, as well as some functions on the PFD (such as, inHG or HPA units for baro set). All buttons are displayed on a black **background**. The selected menu button is highlighted in a green **cursor box**. Some buttons are used in combination. The **ENTER** button on the CCD is used to activate or deactivate the menus and make selections in the control menus. The following are menu button types.

- **Nonexclusive Buttons** – Nonexclusive menu selections are boxes. More than one check box can be checked (contains a green **check mark**) and all checked boxes are considered active. Check box buttons are **black** squares. A green **check** is placed in the white **box** when the **ENTER** button is pushed, or removed when a check mark was already present.

- **Exclusive Buttons** – Mutually exclusive menu selections are circles. Only one selection can be made in this type of menu. Pushing **ENTER** to select a button makes that selection and deselects all other buttons in the menu. Only one active button is permitted at a time. The active button has a green **center**.

- **Toggle Button** – Transitions between the two attributes listed in the text item. The toggle button is used to make a choice between two alternatives. The alternatives are shown in the choice text item in the menu. The **active** choice is white and the **inactive** is gray. The **ENTER** button toggles between two selections.



CREW ALERTING SYSTEM (CAS) WINDOW

The AW139/AB139 PRIMUS EPIC System has a crew alerting system (CAS) that annunciates aircraft system status. The CAS window, as shown in Figure 6-4, shows text messages located in the lower right corner of the MFD. On the PFD/MFD composite display mode, the CAS window is displayed at the bottom center of the composite PFD/MFD.

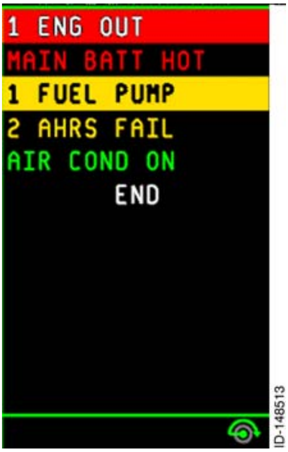


Figure 6-4
CAS Window on the MFD

The CAS system shows four CAS message priority levels. The messages are color coded to reflect their priority and are displayed in the order of descending priority, listed in Table 6-1.

Table 6-1
CAS Message Priorities

Color	Type	Acknowlegement
Red	Warning	Pilot/Copilot
Amber	Caution	Pilot/Copilot
Green	Advisory	Automatic after 5 seconds
White	Status	None
End	Last	None

NOTE: Normal warning messages are displayed as red text on a black background. When displayed using inverse video, red warning messages are displayed as white text on a red background.

- **CAS Message Display Requirements** - The CAS system shows a maximum of 12 messages simultaneously. Each CAS message can be up to 18 characters long including any multiplex indications.

  The CAS system groups the displayed messages with red as the highest priority group being displayed at the top of the column of messages, followed by amber, green, and white.

  Within a group of a particular priority, the messages are displayed in chronological order. The most recent message appears at the top of the stack of messages with corresponding priority.

  New warning and caution messages are displayed in red inverse video or amber inverse video until they are acknowledged. Acknowledged messages are displayed using normal video with a black background. New advisory messages are displayed in green inverse video for six seconds and transition to the acknowledged state. Status messages are displayed using normal video.

- **CAS Message Multiplexing** - When multiple instances of a particular message are possible, the CAS system supports multiplexing the display of these instances on a single line by annunciating the instance identifier(s) together with the message. The format of these multiplexed messages is X-Y-Z where X, Y, and Z are instance identifiers such as the numbers 1, 2, 3 or L (left), C (center) , R (right).

- **CAS Message Enabling** - The logic to enable or disable specific CAS messages is performed by two monitor warning functions hosted on processors in the MAU cabinets.

  The monitor warning logic for display of a CAS message must be satisfied continuously, unless otherwise specified. This occurs before they are enabled or disabled for display. When display of a message is enabled, the message is placed at the top of the active message stack for the correct message priority level.

Avionics CAS messages, listed in Table 6-2, are specific to the EPIC installed on AW139/AB139.

Table 6-2
Avionics CAS Messages

Message	Logic and Conditions
1-2 MAU OVHT	Always enabled. When the MAU is overheating, the NIC sets an over-temperature bit on the ASCB.
*AVIONIC FAULT - ASCB BUS FAIL	Enabled on the ground. Triggered by one or more NICs indicating same ASCB failure.
*AVIONIC FAULT - APM MISCOMPARE	Always enabled. Triggered by the APM Status = Miscompare or Invalid.
*AVIONIC FAULT - CMS FAIL	Always enabled. Triggered by 3-4 APMs reporting APM status is not available. Lower level function messages are inhibited.
*AVIONIC FAULT - 1-2 DISP CNTL FAIL	Always enabled. The control function (CALF) sets bit on ASCB indicates no DC activity.
*AVIONIC FAULT - GC 810 FAULT	Always enabled. The control function sets bit on the ASCB to indicate no GC activity. Triggered when {(GC_Channel1 fails) and (Main Bus 1 Voltage >= 22 volts)} XOR {GC_Channel2 fails) and (Main Bus 2 Voltage >= 22 volts)}
*AVIONICS FAULT - MAU FAN FAIL	Always enabled. Triggered by the failure of one or more MAU FANS.
*AVIONIC FAULT - 1-2 MAU FAULT	Always enabled - Triggered by CORE BIT detection of MAU module inactivity, invalidity of PROC module functions, or Module BIT failures.

Table 6-2 (cont)
Avionics CAS Messages

Message	Logic and Conditions
*AVIONIC FAULT - A429/RS422 BUS	Always enabled - Triggered by loss of communications to a single MAU for the following: TAWS (when installed) AHRS, CHIP detector, EEC1, EEC2, fuel computer left and fuel computer right.
*AVIONIC FAULT - MRC FAULT	Always enabled - Triggered by CORE BIT detection of an MRC NIM module inactivity.
*AVIONIC FAULT - AHRS location	Always enabled. Triggered when there is a mismatch between the AHRS location from the APM and AFCS.
MAINTENANCE	Enabled on ground. Triggered when the parameter group output from CMC module is invalid or not fresh reference. Also, triggered when the CMC sets a bit on ASCB indicating maintenance type fault has occurred in the aircraft.
1-2 MCDU OVHT	Always enabled. Triggered per the MCDU temperature status bit, Label 360 bit 24=1, indicates an over-temperature condition.
1-2-3-4 DU DEGRADE	Always enabled. Triggered by **critical wrap failure** from Monitor Warning function to displays. Lower level function messages are not displayed.
1-2-3-4 DU OVHT	Always enabled. Triggered by a DU Overheat condition. DU sets bit on ASCB indication over-temperature status. Lower level function messages are not displayed.

Table 6-2 (cont)
Avionics CAS Messages

Message	Logic and Conditions
1-2-3-4-5-6-7-8 AUDIO FAIL	Enabled. when APM parameter indicates installed. Triggered when MRC indicates that Audio Panel LRM is failed, over-temperature or has a stuck mic. Also triggered for a MIC or AUDIO BUS failure.
1-2 MRC OVHT	Always enabled. Triggered by over heat condition in radio NIM. NIM sets temperature status to over-temperature.
1-2 VHF COM OVHT	Always enabled. Triggered by a VHF COM over-temperature condition. MRC sets bit on ASCB.
1-2 ADS FAIL	Triggered when calibrated airspeed is invalid, or baro altitude is invalid or pressure altitude is invalid.
1-2 AHRS FAIL	Triggered when pitch angle is invalid, or roll angle is invalid or heading is invalid. PFD also annunciates, either **ATT FAIL** or **HDG FAIL**.
1-2 FMS FAIL	Always enabled. Triggered when FMS status bits are invalid.
AWG FAIL	Always enabled. MW monitors validity and freshness af ASCB transmissions from AW function.
GPS FAIL	Enabled when one FMS is functional. Triggered when the GPS module is either not communicating or reports a failure condition with the status bits.
1-2 GPS FAIL	Enabled when the number of GPS installed is two and at least one FMS is functional. Triggered when the GPS modules are not communicating or reporting a failure condition with their status bits.

Table 6-2 (cont)
Avionics CAS Messages

Message	Logic and Conditions
SYS CONFIG FAIL	Enabled on ground. Triggered after a 5 second debounce by the failure of SCMS to validate system configuration.
VALIDATE CONFIG	Triggered by a change in EPIC hardware or software.
WX TRANSMITTING	Enabled on ground. Triggered by WX transmission while on ground.
VNE MISCOMPARE	Always enabled. Triggered by a miscompare of ADS1 $\mathbf{V_{NE}}$ to ADS2 $\mathbf{V_{NE}}$. Threshold of ± 7 kts.
TAWS AUDIO MUTE	Always enabled. Triggered by bit from TAWS.
TAWS GS CANCEL	Always enabled. Triggered by bit from TAWS.
TAWS LOW ALT	Always enabled. Triggered by bit from TAWS.
CAT A DISP INHIBIT	Enabled when APM parameter indicates CAT A functionality is disabled. Triggered by pushing CAT A button. CAS message reset after 5 seconds.

NOTES:
1. **AVIONIC FAULT** is a combination of any of the failures identified by (*****).
2. A single message or combined message can be displayed. Example: **1 AUDIO FAIL** or **2 AUDIO FAIL** or **1-2 AUDIO FAIL**.

- **Configurable CAS Messages** – The PRIMUS EPIC System provides the capability to customize 10 CAS messages. These messages are enabled by way of the APM parameters and are driven by discrete inputs. In addition, the 18 character message test is controlled by way of the APM parameters. The following APM parameters are used to define each configurable CAS message (where X = 1 to 10):

- ConfigurableCAS MsgXText: Text to be displayed when the logic for this CAS message is satisfied. Text is limited to 18 characters (letters, numeric or special characters).

Table 6-3 is used to define the input discrete for the associated parameter.

Table 6-3
Input Signal For Configurable CAS Messages

APM Parameter	Input Discrete	Discrete Type
ConfigurableCAS Msg1Text	Pilot and Copilot (DC840) 115J1-19	GND/Open
ConfigurableCAS Msg2Text	Pilot and Copilot (DC840) 115J1-20	GND/Open
ConfigurableCAS Msg3Text	Pilot and Copilot (DC840) 115J1-22	GND/Open
ConfigurableCAS Msg4Text	Pilot and Copilot (DC840) 115J1-23	GND/Open
ConfigurableCAS Msg5Text	Pilot and Copilot (DC840) 115J1-24	GND/Open
ConfigurableCAS Msg6Text	Pilot and Copilot (DC840) 115J1-35	GND/Open
ConfigurableCAS Msg7Text	Pilot and Copilot (DC840) 115J1-62	28V/Open
ConfigurableCAS Msg8Text	Pilot and Copilot (DC840) 115J1-63	28V/Open
ConfigurableCAS Msg9Text	Pilot and Copilot (DC840) 115J1-64	28V/Open
ConfigurableCAS Msg10Text	Pilot and Copilot (DC840) 115J1-65	28V/Open

For discrete type GND/Open, the input signal is considered active for the GND state.

For discrete type 28V/Open, the input signal is considered active for the 28V state. In either case, the input signal is considered inactive for the Open state.

All configurable CAS messages are implemented as **status** messages. A configurable CAS message is disabled when corresponding APM parameter is set to null.

When a configurable CAS message is enabled and the corresponding input signal from the pilot or copilot DC is active, then the text defined in the APM parameter is displayed according to priority.

- **Acknowledge Requirements** – Each pilot has a master warning and a master caution annunciator. These annunciators alert the pilot that the CAS display needs to be checked. The annunciators include a button that is pushed to acknowledge messages.

  The master warning and caution annunciators flash when there are caution or unacknowledged warning messages. Pushing the corresponding master warning or caution reset button acknowledges any message status that is unacknowledged. Any caution messages not visible on the CAS display do not have the acknowledge status modified.

  All advisory messages are acknowledged five seconds after they are first visible on the CAS display. Any disabled message is removed regardless of whether it is acknowledged or unacknowledged.

- **Remote CAS Acknowledgement Button** – In addition to the master warning and master caution reset inputs, a remotely mounted master CAS reset button, located on the pilot and copilot collective stick, is used to reset both warning, caution, and aural messages when active.

- **CAS Message Scrolling** – Warning messages cannot be scrolled off the CAS display. The maximum number of warning messages cannot exceed the number of lines in the CAS display. CAS messages of lower priority (caution, advisory, and status), for which display space is not available, can be scrolled when all displayed warning and caution messages have been acknowledged. The messages are scrolled up/down using the cursor control device.

  All messages that are scrolled off the CAS display must be acknowledged. Caution messages are acknowledged using the master caution button or the remotely mounted CAS reset button on the pilot and copilot collective stick. Advisory and status messages are acknowledged five seconds after they first appear on the CAS display.

When a new CAS message becomes active and CAS messages are scrolled off the display, the new message is placed at the top of its respective color stack, and the entire CAS message list from that point down in priority is brought back into view automatically. When all active messages are scrolled off the display and a new caution message becomes active, the new caution message is placed at the top of all the active caution messages. All active caution and advisory messages are brought into view within the limits of the CAS display. When a new message is an advisory message, it is placed at the top of all active advisory messages, and all active advisory messages are brought into view within the limits of the CAS display.

- **CAS Message Status Display** – The last line of the CAS display window is used as a message status line. The purpose is to indicate the existence of non–displayed caution, advisory or status messages and their location relative to the currently in–view messages.

  For each message category (caution, advisory, and status) that has messages scrolled off the top of the display, the CAS status line indicates the number of messages that are scrolled off the display in that direction. This is shown as an up arrow and number color coded to match the color assigned to the corresponding message category (such as, ↑4 meaning four more caution messages are above the display).

  For each message category that has messages scrolled off the bottom of the display, the CAS status line indicates the number of messages that are scrolled off the display in that direction (↓4 meaning four caution messages are below the display).

  When a message is set active but is scrolled out of view due to other unacknowledged messages already being displayed, the corresponding status indication is shown in inverse video (such as, ↑4 for four cautions above or ↓4 for four advisory below).

  When there are less than 12 messages active and all are in view, the message status line is blank. CAS status shows an annunciator that indicates when the cursor control device (CCD) set knob is active and capable of scrolling the CAS messages.

  The end of the message stack is indicated by displaying the message END. The END message is displayed center–justified to distinguish it from normal CAS messages.

- **CAS Miscompare** – The CAS miscompare monitor verifies that both monitor warning functions are producing the same active text messages. The function calculates a checksum for the entire list of active CAS messages. A second checksum is calculated for the warning messages.

A miscompare annunciator (CAS MSCP) is displayed on the PFD when the warning message checksum fails to compare for three seconds, or when the active list checksum miscompares for seven seconds. The miscompare annunciator is located at the bottom left corner of the PFD. The annunciator is in the form nCASMSCP, where n is the number of the monitor warning functions currently being displayed.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When the miscompare is first detected, the CCD cursors are synchronized to the CASMSCP annunciator and a switch symbol (shown at left) is displayed adjacent to the annunciator. When the CASMSCP annunciator is highlighted by the cursor, the pilot can toggle the CAS display between the two monitor warning message lists. This permits the pilot to verify that all messages have been read and resolve the discrepancy.

When the CAS miscompare involves a warning message, the CASMSCP is displayed in red. Otherwise, it is displayed CASMSCP in amber.

POWER (PWR) PLANT MENU

The **Pwr Plant** button on the menu bar is used to select and control display of the MFD power plant windows. When the **Pwr Plant** menu button is highlighted, pushing the **ENTER** button on the CCD shows the MAIN page on the MFD. Moving the joystick down while the **Pwr Plant** menu button is highlighted, shows the **Pwr Plant** drop-down menu, as shown in Figure 6-5.

Figure 6-5
Pwr Plant Menu

Selection of the **Main** prompt on the **Pwr Plant** menu has the same effect as selecting the **Pwr Plant** menu button. Normally, the primary data for each engine is supplied by the electronic engine control (EEC) for that engine. The PRIMUS EPIC system gives analog I/O to perform a backup function for each EEC. The displays perform automatic source selection for the engine data. The source selection always selects the EEC data when it is valid.

The analog menu item is used to manually select analog engine data on the MFD and PFD displays. A check mark is inserted in the check box when the display of analog engine data is selected. When the analog item on the **Pwr Plant** menu is selected, the display system shows analog engine data in place of the EEC data.

Main Page

The **Main** page shows a variety of engine, transmission, and electrical system data. The following parameters are displayed on the **Main** page:

- NG (compressor speed) for engines one and two
- ITT (interturbine temperature) for engines one and two
- TQ (torque) for engines one and two
- NF (power turbine speed) for engines one and two
- NR (rotor speed)
- Engine oil pressure for engines one and two
- Engine oil temperature for engines one and two
- MGB (main gear box) oil pressure and oil temperature
- IGB (intermediate gear box) oil temperature
- TGB (tail gear box) oil temperature
- Deleted
- Fuel pressure for sides one and two
- Hydraulic oil pressure for systems one and two
- Hydraulic oil temperature for systems one and two
- Ammeter for generators one and two
- ESS BUS one and two voltage (DC)
- MAIN BUS one and two voltage (DC)
- Main battery analog ammeter
- Auxiliary battery analog ammeter
- Total fuel quantity
- Fuel quantity for tanks one and two
- Fuel flow for engines one and two.

The **Main** page or **Pwr Plant** page has nine components that are described in the following paragraphs. The layout of the **Main** page is shown in Figure 6-6.

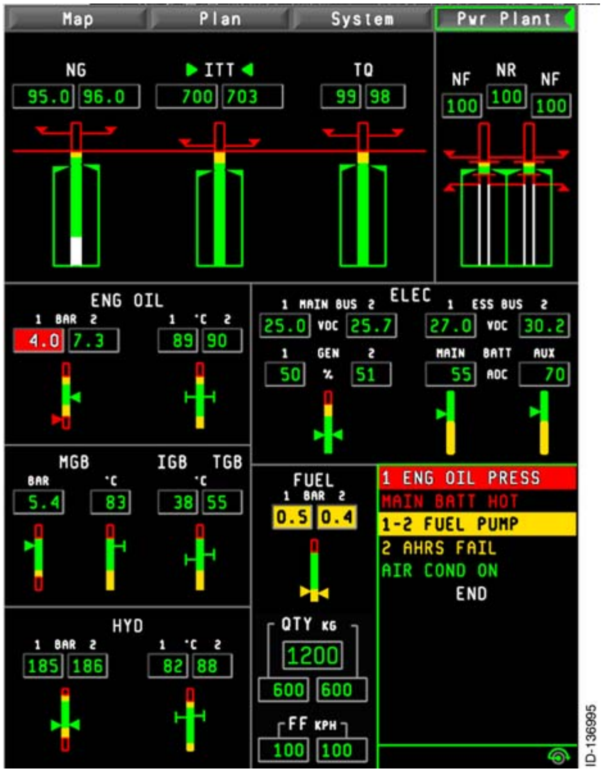


Figure 6-6
MAIN Page

- **Engine Compressor Speed, Inlet Turbine Temperature, and Torque Window** – The color zones for ITT, torque, and NG change depending on the engine rating in use. When the digital display goes into the amber caution range, the digits are displayed in amber inverse video. When the digits are in the red warning range, the numbers are displayed in red inverse video. The three power indicators are displayed, as shown in Figure 6-7.

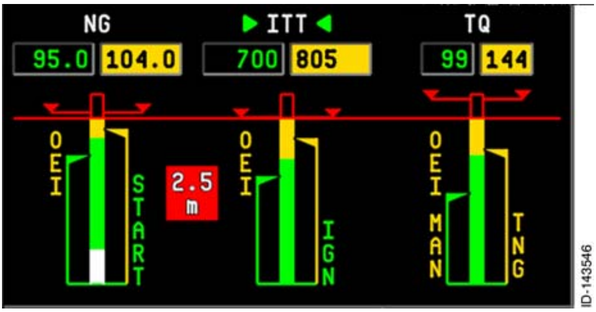


Figure 6-7
Power Indicators

— **NG (Compressor Speed) Annunciator** – The engine compressor speed indicator has bar gauges with red, amber, green, and white zones that indicate engine compressor speed as a percentage of maximum capability (100%). The pointers on the left and right side of the bar point to the current percentage that is displayed in the digital readout box on the top of the bar. The color of the digital readout matches the pointer and zone. The NG limits are listed in Table 6-4.

Table 6-4
NG Compressor Speed Limits

Zone Color	NG Compressor Speed %
All Engines Operating (AEO)	
Red	102.5 – 110
Red ▼	107
Red Line	102.5
Amber	100.1 – 102.4
Green	55.1 – 100
White	0 – 55

Table 6-4 (cont)
NG Compressor Speed Limits

Zone Color	NG Compressor Speed %
One Engine Inoperative (OEI)	
Red	106.1 - 110
Red ▼	107
Red Line	106.1
Amber	102.5 - 106
Green	55.1 - 102.4
White	0 - 55

— **ITT (Inlet Turbine Temperature) Annunciator** - The engine ITT indicator has bar gauges with red, amber, and green zones that indicate ITT in °C or as a percentage. There is an MFD menu selection for choosing ITT that is displayed in either temperature or as a percentage of the AEO MCP ITT (ITT = 735 °C = 100%). The pointers on the left and right side of the bar point to the current temperature that is displayed in the digital readout box on the top of the bar. The color of the digital readout matches the pointer and zone. The ITT limits are listed in Table 6-5.

Table 6-5
ITT Temperature Limits

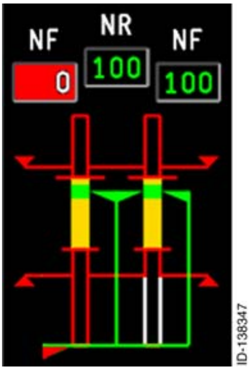
Zone Color	ITT in °C
AEO	
Red	776 – 1176
Red ▼	847
Red Line	776
Amber	736 – 775
Green	368 – 735
Green	-50 – 367
OEI	
Red	836 – 1176
Red ▼	847
Red Line	836
Amber	776 – 835
Green	368 – 775
Green	– 50 – 367
AEO During Start	
Red	870 – 1176
Red ●	1000
Red Line	870
Green	-50 – 869

— **TQ (Torque) Indicator** – The engine torque indicator has bar gauges with red, amber, and green zones that indicate torque in foot pounds. The pointers on the left and right side of the bar point to the current torque value that is displayed in the digital readout box on the top of the bar. The color of the digital readout matches the pointer and zone. The torque limits are listed in Table 6–6.

Table 6–6
Torque Limits

Zone Color	Torque Percentage
Torque AEO	
Red	111 –130
Red ▼	121
Red Line	111
Amber	101 – 110
Green	0 – 100
Torque OEI	
Red	161 – 180
Red ▼	176
Red Line	161
Amber	141 – 160
Green	0 – 140
Green	0 –100

- **Triple Tachometer** – The triple tachometer (tritach) has three elements described in the following paragraphs. The color zones for power turbine speed (NF) and main rotor speed (NR) change depending on the flight condition, such as autorotation, or one engine inoperative.



The tritach is composed of three tachometers that are represented as bar gauges combined together in one graphic display. The tritach continuously monitors NF for both the number one and number two engine and NR. A digital readout is positioned below each annunciator **NF** (for engine one), **NR**, and **NF** (for engine two).

The digital readouts are green when engines and main rotor operate within **normal** operating ranges. The digits are **amber inverse video** or **red inverse video** when operations exceed into the **amber** or **red** range of the bar gauge.

The bar gauges of the tritach are divided into the color segments listed in Table 6-7. The limits are listed in Table 6-8.

Table 6-7
Triple Tachometer Gauge Color Code

Color	Indication
Green	Normal Operating Range • Indicates normal operating conditions exist during ground or flight operations. • Green **lines** parallel to the bar gauge with ends at specific range limits are comparable to the green **arcs** on round dial analog instruments.
Amber	Cautionary Range • Indicates a condition exists during ground or flight operations where limited operations are permissible but caution is required. • Amber **lines** parallel to the bar gauge with ends at specified range limits are comparable to the amber **arcs** on round dial analog instruments.
Red	Emergency Range • Red **displays** indicate an operating limitation has been exceeded and immediate pilot-action required. • Red **lines** parallel to the bar gauge with ends at specified range limits are comparable to the arcs on round dial analog instruments.

Table 6-7 (cont)
Triple Tachometer Gauge Color Code

Color	Indication
Red Lines	• Red **lines** are placed at the limit of a normal operating range. • They define normal maximum limits and certain conditional limits. • Multiple red **lines** can be displayed one at a time. • Multiple red **lines** have distinguishing features, such as one solid line and one dashed line, or lines of different lengths. • Comparable to the red **radial lines** applied to round dial analog instruments.
Transient Range Markings	• Transient range markings indicate engines and main transmission restricted ranges during dynamic conditions of operation such as start-up and acceleration that are of concern for short periods of time. • They are distinct from the steady state limits.
Red Triangle	• Red **triangles** at each end of a red **lines** indicate an in-flight transient limit above a normal maximum limit red **lines**. • A red **dot** indicates a transient condition during engine start-up.
Transient Range	The range, represented by a hollow red **box** at the top of the bar gauge, where a system can be operated above redline in specific conditions and for specific durations.

Table 6-8
NF and NR Limits

Zone Color	NF and NR Power ON/OFF Condition AEO (%)
NF and NR Power ON Condition AEO (%)	
Red Band	104 – 120
NF and NR Power ON Condition AEO (%)	
Red ▼	106
Red Line	104
Amber	102 – 103
Green	98 – 101
Red Line	97
Red ▼	81–97
Red Band	20 – 97
NF and NR Power ON Condition OEI and OEI Training (%)	
Red Band	104 – 120
Red ▼	106
Red Line	104
Amber	102 – 103
Green	98 – 101
Amber	90 – 97
Red Line	89
Red ▼	85
Red Band	20 – 89

Table 6-8 (cont)
NF and NR Limits

Zone Color	NF and NR Power ON/OFF Condition AEO (%)
NR Power OFF Condition - Autorotation	
Red Band	111 - 120
Red ▼	116
NR Power OFF Condition - Autorotation	
Red Line	111
Green	95 - 110
Red Line	94
Red ▼	90
Red Band	20 - 94

- **Engine Oil Displays** - The engine oil indicators, shown in Figure 6-8, have bar gauges with red, amber, and green zones that indicate oil pressure and temperature. The pointers on the left and right side of the bar point to the current pressure or temperature that is displayed in the digital readout box on the top of the bar. The color of the digital readout matches the pointer zone. The oil pressure limits are listed in Table 6-9, and oil temperature limits are listed in Table 6-10.

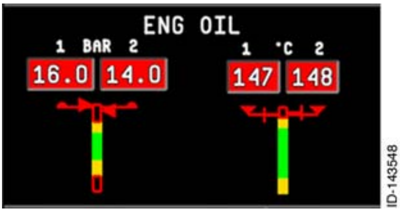


Figure 6-8
Engine Oil Indicators

Table 6-9
Engine Oil Pressure

Zone Color	Oil Pressure (BAR)
Red Band	10.1 – 19
Red ●	15.2
Red Line	10.1
Amber Band	9 – 10
Green	6.3 – 8.9
Amber (low)	4.2 – 6.2
Red Line	4.1
Red Band	0 – 4.1

Table 6-10
Engine Oil Temperature

Zone Color	Oil Pressure (BAR)
Zone Color	Temperature Range in °C
Red Band	146 – 160
Red ▼	150
Red Line	146
Amber Band	141 – 145
Green Band	10 – 140
Amber Band	–50 – 9

- **Main Gear Box (MGB) Displays** – The main gear box indicator

includes two indicators, one indicating gear box oil pressure and the other gear box oil temperature. Both gear box indicators has bar gauges with red, amber, and green zones that indicate BAR and temperature in °C. The pressure pointer (▶) on the left side of the pressure bar and the temperature pointer (sideways T) on the right side of the temperature bar point to the current pressure and temperature that is displayed in the digital readout box on top of the bar. The color of the digital readout matches the pointer zone. The oil pressure limits are listed in Table 6-11 and the temperature limits are listed in Table 6-12.

Table 6-11
Main Gear Box Oil Pressure Range

Zone Color	Main Gear Box Oil Pressure Range (BAR)
Red Band	6.1 – 10
Red Line	6.1
Green Band	3.1 – 6.0
Amber Band	2.3 – 3.0
Red Line	2.2
Red Band	0 – 2.2

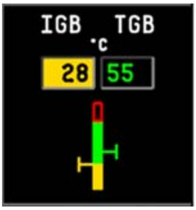
Table 6-12
Main Gear Box Oil Temperature Range

Zone Color	Main Gear Box Oil Temperature Range in °C
Red Band	110 – 150
Red Line	111
Green Band	1– 110

Table 6-12 (cont)
Main Gear Box Oil Temperature Range

Zone Color	Main Gear Box Oil Temperature Range in °C
Amber Band	-50 - 0

- **Intermediate Gear Box (IGB) and Tail Gear Box (TGB) Displays**



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– These annunciators are both bar gauges with red, amber, and green zones that indicate oil temperature in °C. The pointers on the left (IGB) and right (TGB) side of the bar point to the current temperature that is displayed in the digital readout box on the top of the bar. The color of the digital readout matches the pointer zone. The gear box oil temperature limits for both gear boxes are listed in Table 6-13.

Table 6-13
IGB and TGB Oil Temperature Ranges

Zone Color	IGB and TGB Oil Temperatures Range in °C
Red Band	110 - 150
Red Line	111
Green Band	1 - 110
Amber Band	-50 - 0

- **CAS Message Window** – The CAS message window, as shown in Figure 6-9, operates as described previously in this section.

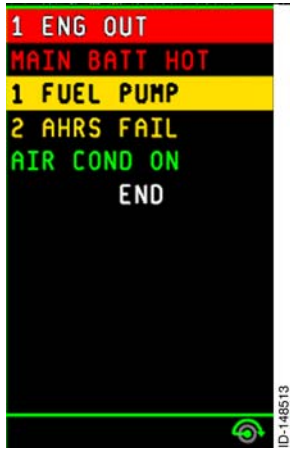


Figure 6-9
CAS Message Window

- **Fuel Pressure Display** – The fuel pressure status annunciator has bar gauges with red, amber, and green zones that indicate fuel pressure for the right and left tanks. The pointers on the left (left tank) and right (right tank) side of the bar point to the current pressure in the tank that is displayed in the digital readout box on the top of the bar. The color of the digital readout matches the pointer zone. The fuel pressure limits are listed in Table 6-14.

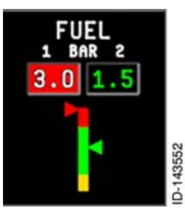
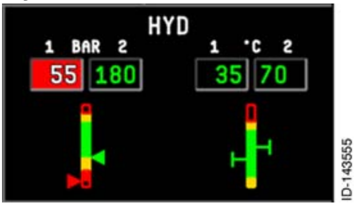


Table 6-14
Fuel Pressure Limits

Zone Color	Fuel Pressure (BAR)
Red Band	2.2 – 2.7
Red Line	2.2
Green Band	0.6 – 2.1
Amber Band	0 – 0.5

— **Fuel Quantity and Flow** – The range for a single tank has a 0 – 900 pound or 0 – 408 kg capacity. The fuel flow indication has a 0 – 999 kg or 0 – 2000 lb indication for single tank and 0 – 2000 kg or 0 – 4400 lb total capacity indication. The fuel flow indication has a 0 –xxx kg/hr or 0 – xxxx lb/hr.

- **Hydraulic Pressure and Temperature Displays** – The hydraulic



pressure and temperature status annunciators are two bar gauges with red, amber, and green zones that indicate hydraulic pressure and temperature for the number one and number two hydraulic systems. The left gauge is hydraulic pressure and the right is hydraulic temperature. The pointers on the left (number one system) and right (number two system) side of each bar gauge point to the current pressure or temperature in the system that is displayed in the digital readout box on the top of the bar. The color of the digital readout matches the pointer zone. The hydraulic pressure limits are listed in Table 6–15, the hydraulic temperature limits are listed in Table 6–16.

Table 6–15
Hydraulic Pressure Limits

Zone Color	Hydraulic Pressure (BAR)
Red Band	251 –310
Red LIne	251
Amber Band	226 – 250
Green Band	180 – 225
Amber Band	163 – 179
Red Line	162
Red Band	0 – 162

Table 6-16
Hydraulic Temperature Limits

Zone Color	Hydraulic Temperature (°C)
Red Band	135 – 150
Red Line	135
Amber Band	120 – 134
Green Band	–20 – 119
Amber Band	–50 – –21

- **Electrical Status Displays** – The electrical status displays, as shown in Figure 6–10, consists of three sets of displays for the main bus one and two, the essential bus one and two systems, the batteries, main and auxiliary.

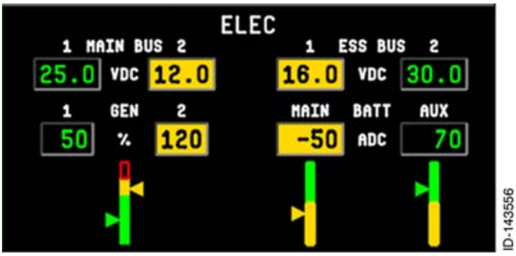


Figure 6–10
Electrical Status Display

— **Main Bus VDC Display** – The main bus display consists of digital voltage for Main Bus one and Main Bus two. The **readouts** are green, but under caution conditions they are **amber inverse video**. The voltage limits are listed in Table 6–17.

Table 6–17
Main Bus Voltage Limits

Zone Color	Main Bus Voltage
Green	≥ 22
Amber	< 22

— **DC Generator Display** – The main bus generator has a bar gauge with red, amber, and green zones that indicate the percentage at which the generator is operating. The pointers on each side of the gauge reflects the color of the digital readout and the zone they are pointing to. The left pointer is for DC Gen one driven by Engine one and the right pointer is for DC Gen two driven by Engine two. The percentage generator load limits are listed in Table 6–18.

Table 6–18
DC Generator Load Limits

Zone Color	DC Generator Load (%)
Red Band	156 – 200
Red Line	156
Green Band	0 – 100
Amber Band	101 –155

— **Essential Bus Voltage Display** – The essential bus display consists of digital voltage for sides one and two. The **readouts** are green, but under caution conditions they are **amber inverse video**. The voltage limits are listed in Table 6–19.

Table 6–19
Essential Bus Voltage Limits

Zone Color	Essential Bus Voltage
Green	≥ 22
Amber	< 22

— **Main and Auxiliary Battery Displays** – The main and auxiliary battery display has a bar gauge with amber and green zones that indicate a charging or discharging condition. The green zone indicates a **charge**, and the amber zone is a **discharge**. The pointers on each gauge reflect the color of the digital readout and the zone they are pointing toward. The battery limits are listed in Table 6-20.

Table 6-20
Main and Auxiliary Battery Loads

Zone Color	Main and Auxiliary Battery Loads (A)
Green	0 – +200
Amber	-200 – 1

ENGINES (SECONDARY) AND SYSTEMS DISPLAY

The secondary engine and system display, as shown in Figure 6-11, is shown as a part of the MFD when the Map, Plan or System mode navigation windows are displayed on the top section of the MFD. The annunciators, which are described in the previous text, include the following:

- Engine oil pressure for engines one and two
- Engine oil temperature for engines one and two
- Main gear box (MGB) oil pressure and temperature
- Intermediate gear box (IGB) oil temperature
- tail gear box (TGB) oil temperature
- Hydraulic oil pressure for system one and two
- Fuel pressure for side one and two
- Total fuel quantity
- Fuel quantity for tank one and two
- Fuel flow for engines one and two.

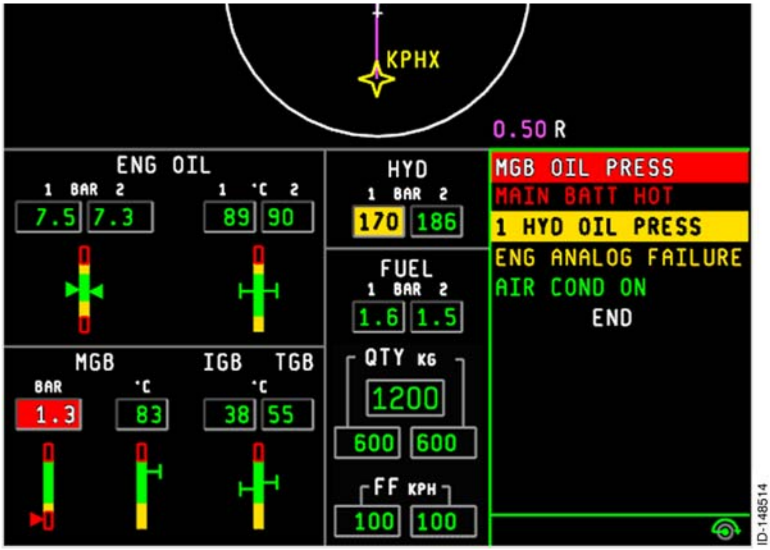


Figure 6-11
Engines (Secondary) and Systems Format

SYSTEMS PAGES

The **System** button on the menu bar is used to select and control the various aircraft system pages that are displayed on the MFD. When the **System** menu button is highlighted, pushing the **ENTER** button on the CCD shows the most recently selected system page. Moving the joystick down while the **System** menu button is highlighted shows the **System** drop-down menu, as shown in Figure 6-12.

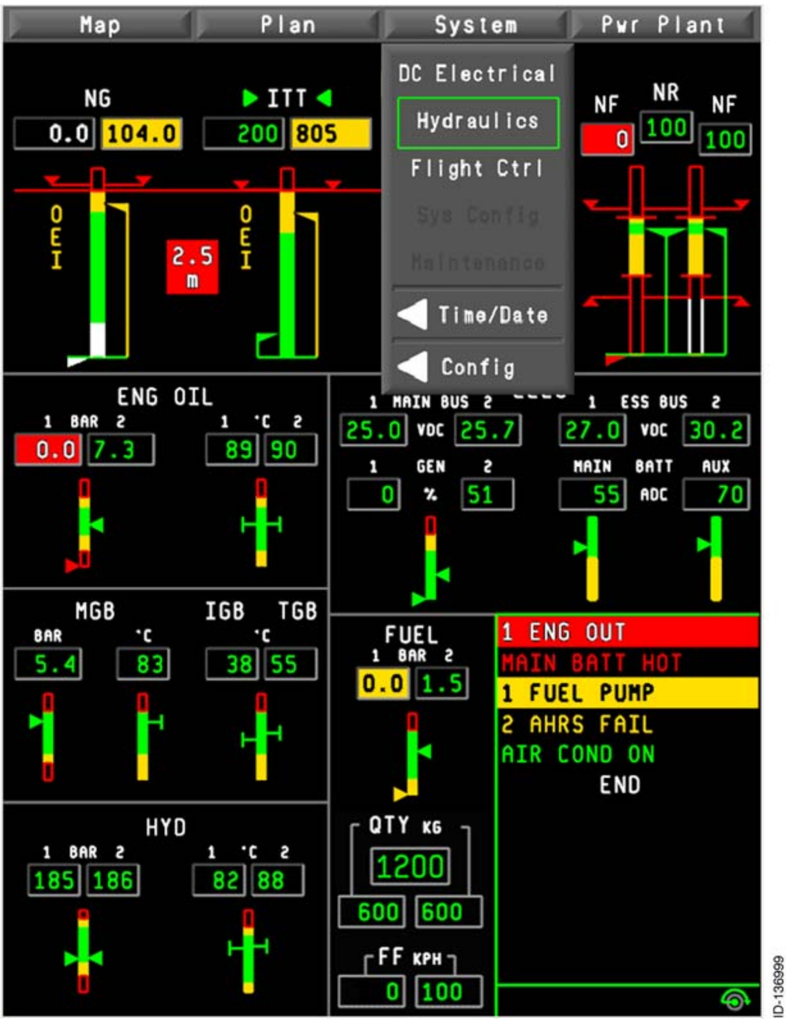


Figure 6-12
MFD System Menu

Selecting the **DC Electrical** menu item shows the DC electrical synoptic page in the upper window of the MFD.

Selecting the **Hydraulics** menu item shows the hydraulic synoptic page in the upper window of the MFD.

Selecting the **Flight Ctrl** menu item shows the flight control synoptic page in the upper window of the MFD.

Selecting the **Maintenance** menu item shows the output of the CMC on the MFD in a full screen format. **Maintenance** is selected when the CMC is valid and the aircraft is on the ground. When this menu item is **not available** for selection, it is displayed in gray, as shown in Figure 6-12.

Selecting the **Sys Config** menu item shows the output of the configuration monitoring function on the MFD in a full screen format. **Sys Config** is selected when the aircraft is on the ground. When this menu item is **not available** for selection, it is displayed in gray, as shown in Figure 6-12.

The **Time/Date** and **Config** menu items permit the selection of submenus, as described on the following pages. Highlighting these items and moving the CCD joystick in the direction of the submenu prompt arrow shows the corresponding submenu.

When video modules (option) are installed in the aircraft, additional menu items are added to the **System** menu for video source displays. The video configuration menu items are located below the **Flight Ctrl** menu item and is separated from the **Flight Ctrl** and **Sys Config** menu items with a horizontal line.

Direct Current (DC) Electrical Synoptic Page

The DC electrical synoptic page, as shown in Figure 6-13, gives the pilot graphical information concerning the status of the DC electrical system. The page is accessible from the **System** drop-down menu on the MFD on the ground or in flight. The major items of the DC electrical synoptic page are:

- Main and auxiliary battery display
- Essential one and two bus display
- Generator one and two display
- Main bus tie display
- Nonessential one and two bus display

- Inverter one and two display
- External power display.

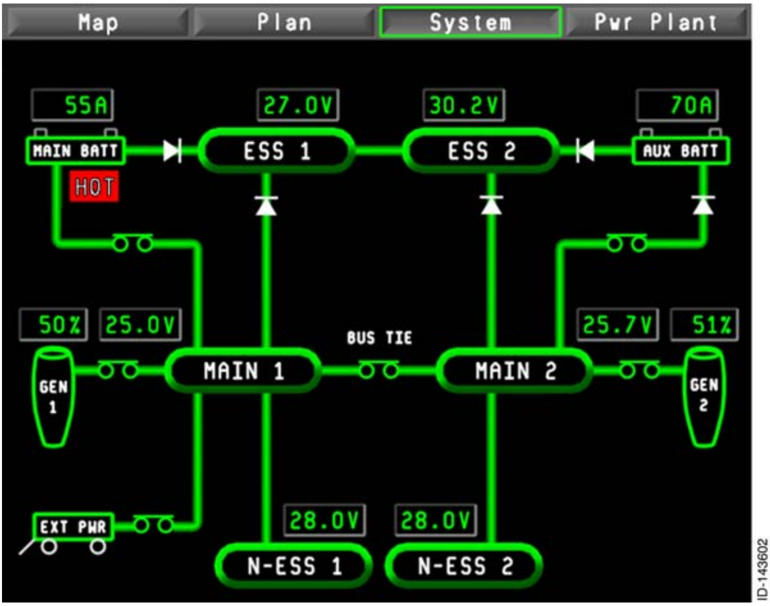


Figure 6-13
Electrical Synoptic

ELECTRICAL SYSTEM OVERVIEW

Two independently driven starter generators supply the DC power. Generator one supplies main bus one when the generator control unit (GCU) status enables this, and the cockpit switch GEN 1 is in the ON position.

Generator two supplies main bus two when the GCU status enables this, and the cockpit switch GEN 2 is in the ON position.

Main buses one and two are connected by the bus tie contactor K10, which commands automatically or manually by the cockpit switch BUS TIE. This enables crossfeeding when a single DC generator failure occurs. The main buses are crossfed during engine start-up.

The main buses give power to the main and auxiliary batteries by way of contactors K3 and K4, for their charging. Batteries are connected to the buses by means of the MAIN and AUX switches located in the cockpit.

The cockpit switch EXT PWR is set to connect the external power to the main bus one, by way of K9, and tie together the two main buses closing K10 (BUS TIE). This enables the distribution of electrical power to all DC buses.

BATTERIES

Two batteries are part of the electrical system. The main battery is connected to essential bus one and gives power for engine starting and during GEN 1 failure.

The auxiliary battery is connected to essential bus two and gives power to the essential avionics equipment to prevent their shut down when low voltage or a power drop occurs.

When a double generator failure occurs, both batteries give continuous power to the two essential buses.

The connection of the batteries to the essential buses are made by contactors K1 (main battery) and K2 (auxiliary battery) that are controlled by the master battery switch (MASTER) in the cockpit.

During normal operation (both generators feeding the main buses), power is not drained from the batteries and act as a stand-by reserve of power. When both generators fail, the batteries automatically feed the essential buses without any interruption.

In normal operation (flight and ground), the batteries are charged by the two DC generators. When external power is enabled, batteries are prevented from charging.

PILOT CONTROLS

The pilot manually initiates and controls the DC power system through the control panel, shown in Figure 6-14, located in the overhead panel.

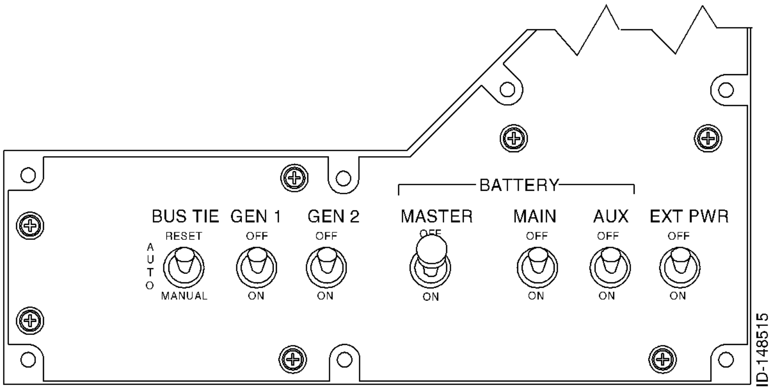


Figure 6-14
Electrical System Control Panel

The function of the panel toggle switches are listed in Table 6-21.

Table 6-21
Pilot Electrical System Controls

Control Switch	Function
BATTERY MASTER	Connects both the batteries to the essential buses, closing K1 and K2 contacts.
MAIN BATT	When the battery switch is ON, the main battery connection to the number one main feeder is enabled by closing K3 contact.
AUX BATT	When the battery switch is ON, the auxiliary battery connection to the number one main feeder is enabled by closing K4 contact.
GEN 1	Enables the DC GEN 1 GCU. When the generator reaches the operating speed, generated power is connected to the bus (K5 closes).

Table 6-21 (cont)
Pilot Electrical System Controls

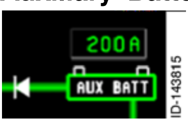
Control Switch	Function
GEN 2	Enables the DC GEN 2 GCU. When the generator reaches the operating speed, generated power is connected to the bus (K6 closes).
BUS TIE	When moved to the MANUAL position, it ties the main bus one and main bus two feeders by closing the K10 contact. When a bus fault is detected, the tie is inhibited by the bus fault logic. (The buses are normally isolated). When moved to the momentary RESET position, it resets the logic involved in the crosstie of the main buses and isolation of the batteries from the main buses. When moved to the AUTO position, automatic activation of the bus tie feature is enabled during single generator or external power operation.
EXT PWR	Connects external DC power to the system by the main bus one and automatically disconnects all batteries and generators from the main buses.

The convention for defining the status of the synoptic page parameter and the relationship with the related discrete signals are defined in the following paragraphs:

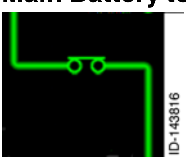
- **Main Battery** – The main battery icon includes a battery symbol and

a pipeline connection with a diode in series. The battery and its lines are green when the battery is on-line. When the battery is off-line, the battery box is white and the pipeline is gray. OFF is displayed next to the battery, and the BATT OFF LINE CAS message is displayed. The battery current digital display 200A is displayed above the main battery symbol. This display value is the same value shown on the EICAS display.

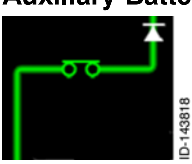
- **Auxiliary Battery** – The auxiliary battery annunciator appears identically to the main battery display.



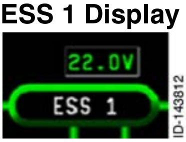
- **Main Battery to MAIN 1 Line and Switch** – This segment consists of a pipeline connection and a switch. The segment and switch are green when the main battery is ON and the switch is closed. The pipeline is gray and the switch is white and open when the main battery is OFF. When the main battery is OFF the MAIN BATT OFF CAS message is displayed.



- **Auxiliary Battery to MAIN 2 Line and Switch** – This pipeline segment and switch are displayed in green and the switch is closed when the AUX BATT is not OFF and MAIN BUS 2 voltage is ≥15V. The segment is gray and the switch is white and open when AUX BATT is OFF or MAIN BUS 2 voltage is < 15V. This segment acts the same as the main battery one to main one line, except, the AUX BATT OFF CAS message is displayed.

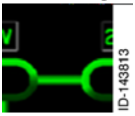


- **ESS 1 Display** – The essential bus one display is green when the voltage is ≥15 V dc. It is green with an amber X when the voltage is <15 V dc. This symbol must be green at all times. When the master battery is ON, the bus is powered. If not, it means that the circuit breakers CB 1, CB 47, CB 3, and CB 120 are tripped. Voltage digital readouts are located above the bus symbol ESS 1. This display is the same as the one on the MFD main page display.



- **ESS 2 Display** – The essential bus two display operates identically to the essential bus 1 display. When the master battery is ON, this bus is powered. If not, it means that the circuit breakers CB 2, CB 48, CB 4, and CB 120 are tripped.

- **LIne Segment Between ESS 1 and ESS 2** – This pipeline shows a connection between the ESS 1 and the ESS 2 symbols. Schematically, it is circuit breaker **CB 120**. It is green when the voltage difference between ESS 1 and ESS 2 is < 3 V dc. It is green with an amber **X** when the voltage difference is > 3 V dc. This **line** is green at all times. When the master battery is ON, this line is powered. When the delta voltage between the two essential buses is more than three volts, it means that the circuit breaker CB 120 has tripped.



- **Undetermined** – When a parameter is used to determine the state of a synoptic segment as invalid or no-computed data (NCD), the segment is displayed with amber dashed lines, as shown in Figure 6-15.

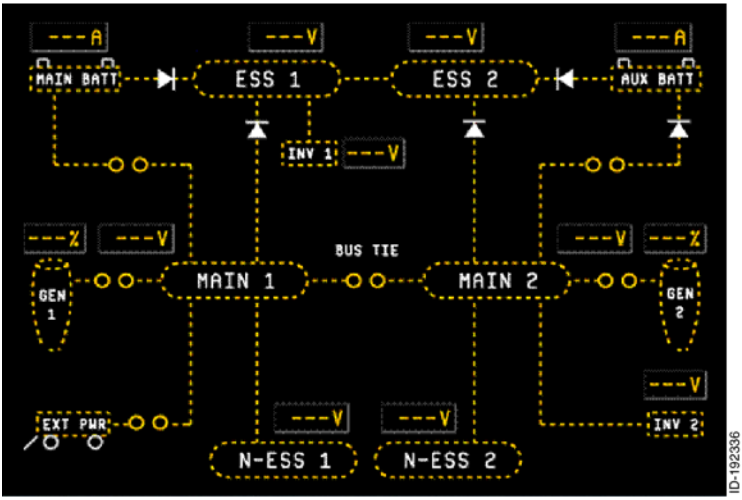
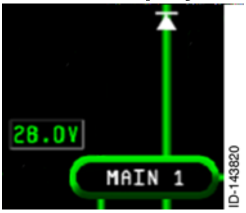


Figure 6-15
Example of Undetermined Synoptic Page

- **MAIN 1 Display** – The MAIN 1 symbol with a connection to the symbol ESS 1 consists of a pipeline segment with a diode in series. The symbol is white when the following are true:



— Bus voltage $\leq$15 V dc
— External power OFF
— Generator one has failed
— Main battery is OFF
— The bus tie is open

The symbol is green when:

— MAIN BUS 1 VOLTAGE is $\geq$15V

The segment and diode is green with an amber X when:

— MAIN BUS 1 VOLTAGE is < 15V BUS TIE OPEN discrete is not true or EXT PWR is ON or GEN 1 is not failed or MAIN BATT is ON.

When the main bus voltage is > 15 V dc, the **symbol** and **pipeline** are green. The MAIN 1 symbol is green with an amber **X** when the voltage is < 15 V dc and any one of the following are feeding MAIN 1:

— External power

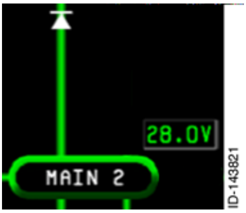
— Generator one

— Main battery

— Generator two and the bus tie is open.

The electrical system synoptic page shows a MAIN BUS 1 voltage digital readout adjacent to the MAIN 1 symbol. This display is the same as displayed on the EICAS display.

- **MAIN 2 Display** – The **MAIN 2** display is connected to the symbol **ESS 2**. The connection is composed of a pipeline segment with a diode in series. The **symbol** is white (OFF condition) when:



— MAIN BUS 2 voltage is < 15V, and GEN 2 is failed and AUX BATT is OFF and the BUS TIE is open.

NOTE: MAIN BUS 2 is OFF when it does not receive power by way of the bus tie contactor from Generator 2, Auxiliary Battery and Generator 1.

The **symbol** is green when MAIN BUS 2 voltage $\geq$ 15V.

The **symbol** is green with an amber **X** when MAIN BUS 2 voltage is < 15V and the BUS TIE is not open, or GEN 2 FAIL has not failed, or AUX BATT is ON.

The MAIN BUS 2 has failed when there is low voltage, but one of the following sources is feeding the MAIN LOAD BUS 2:

— Generator two

— Auxiliary battery

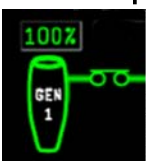
— Generator one or external power by way of the bus tie contactor.

- **BUS TIE Segment** – The **BUS TIE** segment consists of a switch and pipeline segment between symbols MAIN 1 and MAIN 2. The bus tie switch is open when the **line segments** are gray, the load on GEN 1 and 2 are ≥3% and neither generator has failed. When the bus tie switch is closed, the **switch** and **pipelines** are green. The switch is open with an amber **X** on the gray **pipeline** segment (failed OPEN) when both generators have failed or the loads are <3%.

ID-143822

NOTE: The **BUS TIE OPEN** is displayed in the CAS window and the **OPEN** caution flag is displayed under the same conditions as described previously.

- **GEN 1 Display** – The **GEN 1** symbol with a switch is connected in series to MAIN 1. The **symbol** is green when the switch is closed, Generator 1 has not failed, and the load is ≥3%. The **symbol** is green with an amber **X** when the switch is open and the load is < 3%. The GEN 1 load meter digital readout is displayed above the **GEN 1** symbol. The loadmeter value has the same percentage value that is indicated on the EICAS display.



ID-143819

NOTE: The caution **1 DC GEN** is displayed in the CAS window when the previous conditions occur.

The **GEN 1** symbol is amber, dashed (**- - -**) and the switch is undetermined when any of the following conditions exist:

— GEN 1 load is < 3% GEN 1 and it has not failed, or GEN 1 load ≥3% and GEN 1 has failed.

— GEN 1 load ≥3%, GEN 1 has not failed, and engine out or NG1 <50% is indicated.

The **GEN 1** **symbol** is green with a red **X** and the switch is open (A red **X** represents GEN 1 AND GEN 2 FAILURES) when:

— GEN 1 load < 3% and GEN 1 FAIL is true, and

— GEN 2 load < 3% and GEN 2 FAIL is true, and

— EEC 1 discrete switch W1.4 = 0 and 1 ENG OUT discrete is open and NG1 > 55%, and

— EEC 2 discrete switch W1.4 = 0 and 2 ENG OUT discrete is open and NG2 > 55%.

NOTE: The above condition occurs when the warning message **1-2 DC GEN** is displayed in the CAS window.

The GEN 1 symbol is white and the switch is open (GEN 1 OFF) when:

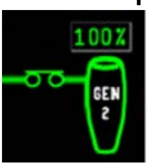
— GEN 1 load < 3%, and

— GEN 1 FAIL is true, and

— EEC 1 discrete switch W1.4 = 1 or 1 ENG OUT discrete = GND, or NG1 < 50%.

The GEN 1 loadmeter display readout is displayed above the GEN 1 symbol. The loadmeter value has the same percentage value indication as the EICAS display.

- **GEN 2 Display** – The electrical synoptic page shows a GEN 2 symbol with a switch connection in series to the MAIN 2 symbol. The GEN 2 symbol is green and the switch is closed (GEN 2 normal operation) when:



ID-143847

— GEN 2 load is ≥3%, and

— GEN 2 is not failed, and

— EEC 2 discrete switch W1.4 = 0, 2 ENG OUT discrete is open, and NG2 is> 55%.

The GEN 2 symbol is green with an amber X and the switch is open (GEN 2 failure) when:

— GEN 2 load is < 3%, and

— GEN 2 has failed, and

— EEC 2 discrete switch W1.4 = 0, 2 ENG OUT discrete = open, and NG2 is > 55%.

NOTE: The caution 2 DC GEN is displayed in the CAS window when the previous condition occurs.

The GEN 2 symbol is amber dashed (- - -) and the switch undetermined (GEN 2 undetermined: the analog voltage or the discrete is annunciating the failure) when:

— GEN 2 load is < 3%, and

— GEN 2 has not failed, or GEN 2 load is ≥3% and GEN 2 has failed, or

— GEN 2 load is ≥3%, and

— GEN 2 has not failed, and

— EEC 2 discrete switch W1.4 = 1 or 2 ENG OUT discrete = GND or NG2 is < 50%.

The **GEN 2** **symbol** is green with a red **X** and the switch opens (**GEN 1** and **GEN 2** failures are represented by both generator symbols with a red **X**) when:

— GEN 1 load is < 3% and GEN 1 has failed, and

— GEN 2 load is < 3% and GEN 2 has failed, and

— EEC 1 discrete switch W1.4 = 0 and 1 ENG OUT discrete is open, and

— NG1 is > 55%, and

— EEC 2 discrete switch W1.4 is 0, and 2 ENG OUT discrete is open, and

— NG2 is > 55%.

The **GEN 2** symbol is white and the switch is open (**GEN 2** is OFF) when:

— GEN 2 load is < 3%, and

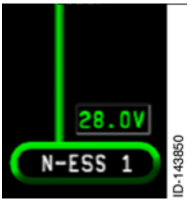
— GEN 2 has failed, and

— EEC 2 discrete switch W1.4 is 1, or ENG OUT discrete is ground, or

— NG2 is < 50%.

The **GEN 2** loadmeter display readout is displayed above the **GEN 2** symbol. The loadmeter value has the same percentage value indication as the EICAS display.

- **N-ESS 1 Display** – The display consists of a bus symbol labeled N-ESS 1 with a pipeline segment connection to the symbol MAIN 1. The symbol is green when the N-ESS 1 voltage is ≥15 V dc. The N-ESS 1 symbol is white with a gray pipeline when any of the following conditions exist:



  — N-ESS Bus 1 voltage is < 15 V dc, and

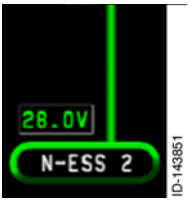
  — Either GEN 1 or GEN 2 has failed, and

  — Either GEN 1 or GEN 2 loads are < 3%, and

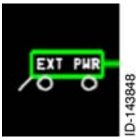
  — The bus tie is closed.

  The symbol is green with an amber X when N-ESS 1 voltage is <15 V dc, neither generator has failed, and the bus tie is open. The N-ESS digital voltage value is displayed above the N-ESS 1 symbol and is the same as displayed on the EICAS display.

- **N-ESS 2 Display** – The N-ESS 2 display consists of a bus symbol labeled N-ESS 2 with a pipeline segment connection to the symbol MAIN 2. The symbol operates the same way as the N-ESS 1 symbol, except the logic views at the N-ESS 2 voltage instead of N-ESS 1 voltage.



- **EXT PWR (External Power) Cart** – The EXT PWR cart is displayed or removed according to whether the external power door is open or closed. When it is closed, the EXT PWR cart is not displayed. When the external power door is open, the EXT PWR DOOR CAS message and cart are displayed.



  The color of the rectangle is white with gray wheels indicating the electrical system is ready to accept external power supply when:

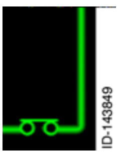
  — External power door is open, and the EXT PWR indicates that power is not ready to be applied.

The color of the **rectangle** is green when:

— The external power door is open, and power the EXT PWR discretes indicate that power is ready to be applied (such as, active = 28 V dc, meaning that a voltage with a proper range is available at the aircraft input connector).

NOTE: When power is connected and within required power limits, the **cart** turns green, and the **EXT PWR ON** CAS message is displayed.

- **EXT PWR Switch and Pipeline** – The pipeline and switch are



located between the EXT PWR cart and the MAIN 1 bus symbol. This connection is not shown when the external power door is closed or when the door is open and the connection has not yet been made. The **connection** is gray when the connection has been made and the switch has not been closed. When the switch is closed, the switch appears closed, the **switch** and **pipeline** show green, and the CAS message **EXT PWR ON** is displayed.

DC ELECTRICAL SYNOPTIC PAGE CAUTIONS AND WARNINGS

Many cautions and warnings are associated with the DC Electrical Synoptic page, as shown in Figure 6-16. All cautions and warnings associated with this page are described in the following paragraphs.

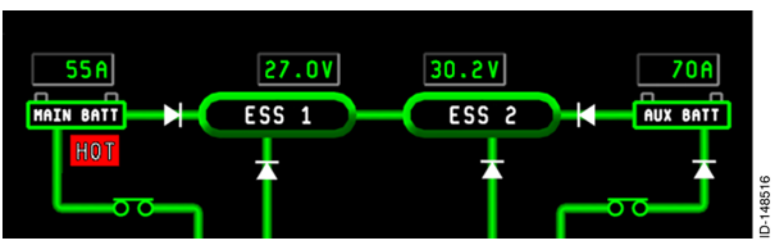


Figure 6-16
Example of DC Synoptic Page Caution and Warning Locations

- **MAIN BATTERY HOT Warning Flag** – The main battery hot warning flag is a **HOT** annunciator that is displayed near the affected battery. It indicates the main battery is approaching a high and dangerous temperature. The warning flag appears under the same conditions when the warning message **MAIN BATT HOT** is displayed on the CAS display.

- **AUX BATTERY HOT Warning Flag** – The auxiliary battery hot warning flag is a HOT annunciator that is displayed near the affected battery. It indicates the auxiliary battery is approaching a high and dangerous temperature. The warning flag appears under the same conditions when the warning message AUX BATT HOT is displayed on the CAS display. The flag is removed when the CAS message is removed.

- **GENERATOR 1 HOT Caution Flag** – The caution flag indicates that GEN 1 is approaching a high temperature. The flag HOT is displayed near the GEN 1 symbol. This caution flag appears under the same conditions as the caution message 1 DC GEN HOT or 1-2 DC GEN HOT displayed on the CAS display. The flag is removed when the CAS message is removed.

- **GENERATOR 2 HOT Caution Flag** – The caution flag indicates that GEN 2 is approaching a high temperature. The flag HOT is displayed near the GEN 2 symbol. This caution flag appears under the same conditions as the caution message 2 DC GEN HOT or 1-2 DC GEN HOT displayed on the CAS display. The flag is removed when the CAS message is removed.

- **BUS TIE OPEN Caution Flag** – The caution flag indicates that the bus tie contactor did not close automatically after the loss of one of the generators. The bus tie open caution flag OPEN is located near the bus tie switch symbol. The flag is displayed when GEN 1 or GEN 2 load is < 3% and one of the other generators has failed.

Hydraulic Synoptic Page

The hydraulic system consists of two independent subsystems (HYD SYS-1 and SYS-2) and one dedicated control panel, shown in Figure 6-17. Each subsystem gives hydraulic power to the flight control servos and the landing gear actuators.

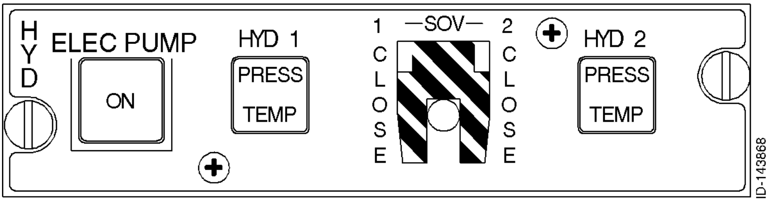


Figure 6-17
Hydraulic System Control Panel

The status of the hydraulic system, including the pressure, temperature, and CAS messages, is displayed in the cockpit on the multifunction display (MFD). The Hydraulics synoptic page, as shown in Figure 6-18, shows a diagram of the aircraft hydraulic system and includes graphic indications of the systems status.

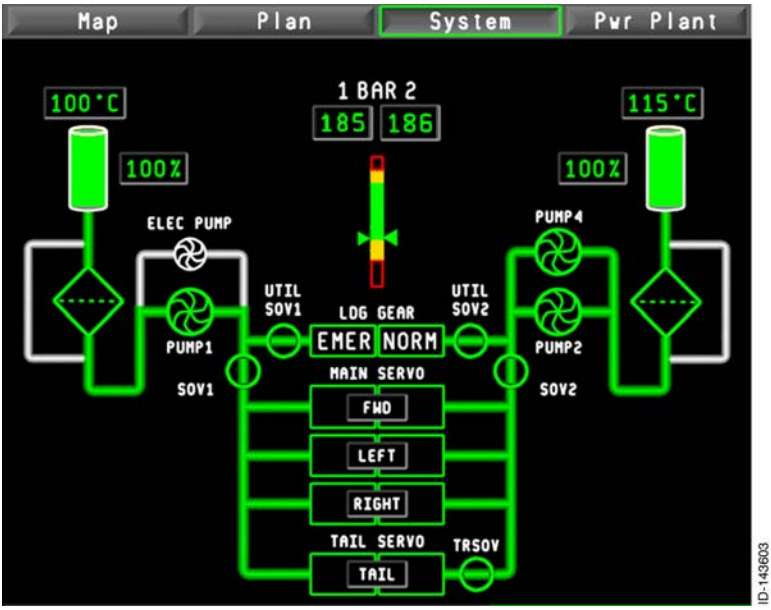


Figure 6-18
Hydraulic Synoptic Page

The major items on the Hydraulics synoptic page include:

- Hydraulic oil pressure displays
- Hydraulic reservoir displays
- Hydraulic oil filters
- Hydraulic reservoir quantity displays
- Hydraulic oil temperature displays
- Hydraulic pump displays
- Electrical pump display
- Shut-off valve displays
- Main servo user display
- Tail servo user display.

When the aircraft rotor is running, the Hydraulic System 1 is powered by one mechanical pump (PUMP 1). System 1 is identified as the left system and it gives hydraulic power to the main servos, tail servo, and the landing gear (emergency actuation). In addition, as part of Hydraulic System 1, an electrical pump (EP) is given to enable limited checks of the servos on the ground with no engine running.

The System 1 includes the following items relevant for the synoptic page.

- One oil tank, including:
  - 50%, 28%, and 22% oil level switches
  - One oil temperature transducer
  - One oil temperature switch
- One oil filter, including:
  - One bypass system
  - One filter clogged switch
- One mechanical pump (PUMP 1), including:
  - One pressure switch
- One electrical pump (EP)
- One shut-off valve (SOV 1), including:
  - One status switch
- One utility shut-off valve (UTIL SOV1)
- One oil pressure switch (EMER LG PRESS)
- One oil pressure transducer (for the HYD1 line)
- One oil pressure switch (for the HYD1 line).

When the aircraft rotor is running, System 2 (identified as the right system) is powered by two mechanical pumps (PUMP 2 and PUMP 4). System 2 gives hydraulic power to the main servos, tail servo, and the landing gear (normal actuation).

The System 2 includes the following major items relevant for the synoptic page.

- One oil tank, including:
  - 50%, 28%, and 22% oil level switches
  - One oil temperature transducer
  - One oil temperature switch

- One oil filter, including:
  - One bypass system
  - One filter clogged switch
- Two mechanical pumps (PUMP 2 and PUMP 4), including:
  - One pressure switch for each pump
- One shut-off valve (SOV2), including:
  - One status switch
- One utility shut-off valve (UTIL SOV2)
- One oil pressure switch (UTILITY HYD PRESS)
- One tail rotor
- Shut-off valve (TRSOV), including:
  - One status switch
- One oil pressure transducer (for the HYD2 line)
- One oil pressure switch (for the HYD2 line).

PAGE OPERATION

In normal conditions, no flight crew action is required for the hydraulic system operation and both subsystems supply hydraulic power to the loads.

When an oil leak in one of the subsystems is detected by the level-switches (installed in the tanks), the hydraulic system takes the following actions:

- Leak on subsystem one
  - When the 50% oil level switch is active, a maintenance message is generated.
  - When the 28% oil level switch is active, a maintenance message is generated.
  - When the 22% oil level switch is active, the UTIL-SOV 1 closes, the CAS message is activated and a maintenance message is generated.

- Leak on subsystem two

  — When the 50% oil level SW is active, the UTIL-SOV 2 closes and a maintenance message is generated.

  — When the 28% oil level SW is active, the TRSOV closes, the UTIL-SOV 2 opens, and a maintenance message is generated.

  — When the 22% oil level SW is active, the UTIL-SOV 2 closes, the TRSOV remains closed, the CAS message is activated, and a maintenance message is generated.

When oil pressure loss ($\leq$162 BAR) is detected by a pressure sensor or a pressure switch, the system activates a CAS message and a maintenance message is generated.

When oil over-temperature (>135°C) is detected by a temperature sensor or a temperature switch, the system activates a CAS message and a maintenance message is generated.

When one oil filter is clogged and detected by a pressure switch, the system automatically bypasses the clogged filter and generates a maintenance message.

The operator can manually close SOV-1 or SOV-2 (alternatively), when it is necessary to isolate the servo from the line by way of a switch on the hydraulic control panel.

The operator can activate the EP by pushing the correct button on the hydraulic control panel. This enables limited checks of the flight controls without starting the engines. When the system does not apply any interlock, the operation is permitted on the ground when the rotor is not running.

- **Flow Lines** - Flow lines within a contactor are displayed in front of contactors. Flow lines are listed in Table 6-22.

Table 6-22
Flow Line States

FLOW LINE STATE	FLOW LINE GRAPHIC
'NO FLOW'	
'FLOW'	
'UNDETERMINED'	

ID-143869

- **Pumps** – Pump icons are listed in Table 6–23.

Table 6–23
Pump States

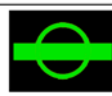
PUMP STATE	PUMP GRAPHIC
'OFF'	
'FAILED OFF'	
'ON'	
'FAILED ON'	
'UNDETERMINED'	

ID-143870

NOTE: The failed **X** over the pump matches the color of the displayed CAS message. Therefore, the icon can have an amber X or a red X.

- **Valves** – Valve icons are listed in Table 6–24.

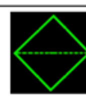
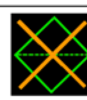
Table 6–24
Valve States

VALVE STATE	VALVE GRAPHIC
‘CLOSED’	
‘OPEN’	
‘FAIL OPEN’	
‘UNDETERMINED’	

ID-143871

- **Filters** – Filter icons are listed in Table 6–25.

Table 6–25
Filter States

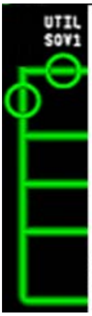
ITEM	FILTER STATE	FILTER GRAPHIC
HYDRAULIC OIL FILTER	‘NORMAL’	
	‘CLOGGED’	
	‘UNDETERMINED’	

ID-143872

- **PUMP 1 Icon** – The HYD PUMP1 symbol and its flow line connections are in series to the flow lines in segment L1 and L4. The flow line status for this segment is the same as described in the previous bullet point. The pump icon follows the logic listed in Table 6-23.

- **L4 Flow Line** – This flow line connects the HYD PUMP1 to the shut-off valve one (SOV1) and utility shut-off valve one (UTIL SOV1). The **lines** are green when hydraulic pressure is ≥162 psi or the electrical pump is ON. Otherwise, the **flow line** has no flow and is gray.

- **SOV 1 (Shut-Off Valve 1) Icon** – This shut-off valve lies between the L4 flow line and the L6 flow line. The valve is closed when the hydraulic system pressure switch is ON. The valve is open when the hydraulic system one pressure switch is OFF. The status is **failed** when the shut-off valve is open, the hydraulic system pressure switch is ON, and the hydraulic servo fail switch is ON. Otherwise, the SOV1 status is undetermined.



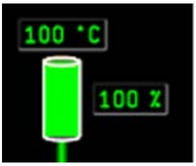
ID-143885

- **Utility SOV 1 Icon** – The utility shut-off valve and the flow line connect between the L4 flow line and the landing gear emergency actuation box. It has two states, open and closed as set by the pilot.

  — The valve is closed when the HYD1 MIN LEVEL switch and the EMER LG PRESS switches are ON.

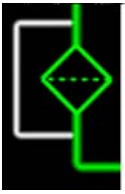
  — The valve is open when both switches are OFF.

- **Oil Level Tank 1 Icon** – The Tank 1 icon is located above Filter 1. It operates as listed in Table 6-26.



ID-143882

- **FILTER 1 Icon** – The OIL FILTER 1 symbol is connected to the oil tank 1 from above and hydraulic pump one from the bottom. It annunciates as listed in Table 6-25.



ID-143883

- **L12 Flow Line Icon** – The L12 line is a bypass flow line connected in parallel with the OIL FILTER 1. The **line** is green when the hydraulic pressure is ≥162 psi and the hydraulic filter clogged switch is ON. Otherwise, there is no flow and the **line** is gray.

- **SERVO Icons** – The SERVO icons are boxed symbols for servos and connections. This segment includes four boxed symbols for the main forward servo, the main left servo, the main right servo, and the tail servo. When the servos are **valid** they are green. When a servo **fails** the box turns amber.

- **EMERGENCY/NORMAL Landing Gear Icon** – The emergency/normal box is a symbol for landing gear emergency actuation, and the connections with the U4 UTIL SOV1. The box is green when the status is **valid** and amber when the status is **invalid**.

The right hydraulic system operates the same as the left side described previously, with the exception that the right has a tail rotor SOV valve.

The tail rotor shut-off valve (TRSOV) is on the right side of the hydraulic system synoptic page displaying a tail rotor shut-off valve between the R6 flow line and R8 flow line. The status for TRSOV is closed when the TRSOV switch is closed, and HYD2 low level is 28%, or HYD2 minimum level is 22%. Otherwise, the TRSOV is open.

- **Hydraulic System 1 and System 2 Oil Pressure Indicator** – This indicator is a single vertical scale with one analog pointer and one digital readout for both HYD SYS1 and SYS2 oil pressure. The digital readout shows the same value as on the EICAS display. The color of the pointers match the color of the area on the scale they are pointing to: red, amber, and green. The digital readouts display red when the pointer is in the red zone (**warning**) and amber when the pointer is in the amber zone (**caution**). Otherwise, the digits are green (**normal**).

MAU FAILURE

When MAU 1 fails, the hydraulic system synoptic page shows the following segments and symbols as UNDETERMINED, as shown in Figure 6-19:

- OIL TANK 1 (segment L7, L8, L9a, or L9b)
- OIL TANK 2 (segment R9, R10, R11a, or R11b)
- TANK 1 OIL LEVEL DIGITAL READOUT (segment L10)
- TANK 2 OIL LEVEL DIGITAL READOUT (segment R12)
- EMER LDG SERVO (segment U5)
- SOV1 (segment L5).

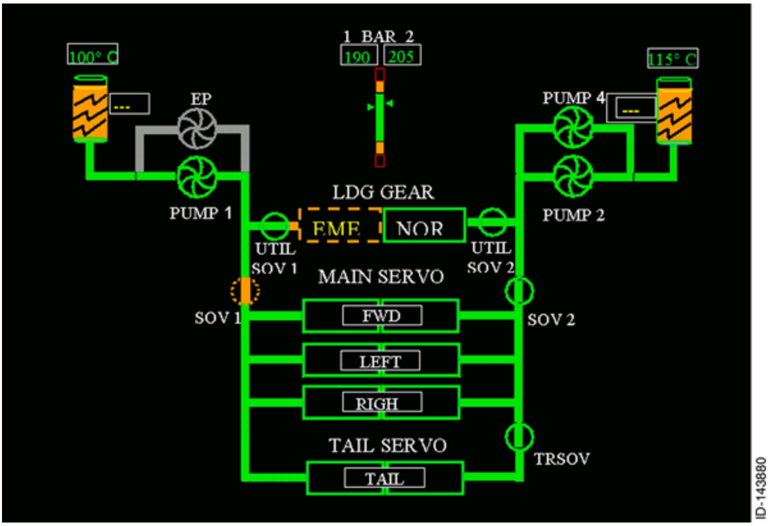


Figure 6-19
MAU Failure Display Example

When MAU 2 fails, the hydraulic system synoptic page shows the following segments and symbols as UNDETERMINED.

- OIL TANK 1 (segment L7, L8, L9a, or L9b)
- OIL TANK 2 (segment R9, R10, R11a, or R11b)
- TANK 1 OIL LEVEL DIGITAL READOUT (segment L10)
- TANK 2 OIL LEVEL DIGITAL READOUT (segment R12)
- PUMP1 (segment L3)
- SOV2 (segment R5)
- TRSOV (segment R7).

Automatic Flight Control System (AFCS) Synoptic Page

The AFCS synoptic page, as shown in Figure 6-20, shows the positions of all linear actuators. Following failure of the AFCS trim system, the pilot uses the actuator position indications to determine when manual retrimming is required.

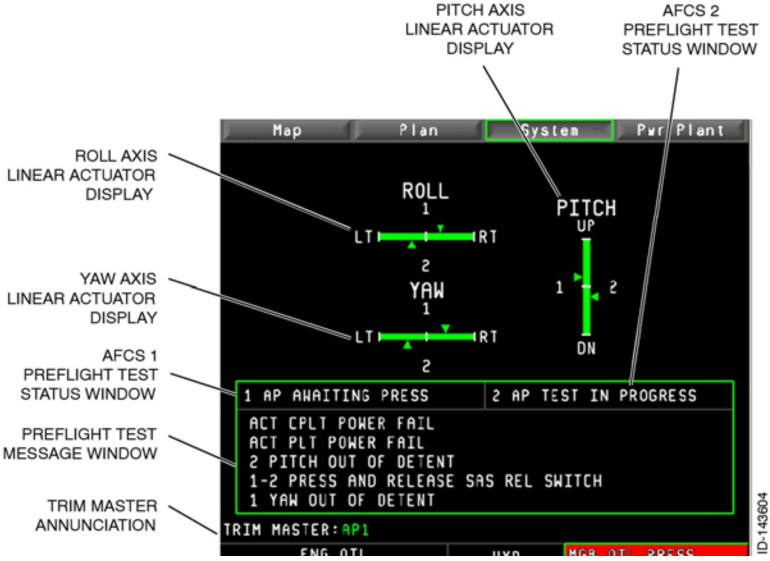


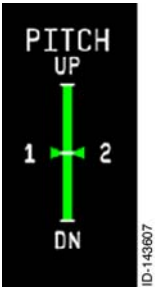
Figure 6-20
AFCS System Synoptic

Three scales are shown. One for each of the pitch, roll, and yaw axes. The positions of the two actuators in each axis are shown using a triangle pointer located on either side of the scale.

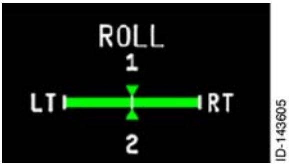
The AFCS synoptic page indicates which AFCS is currently controlling the trim actuators.

When neither AP is engaged, and one AFCS is valid, the display trim master is a green **NA** .

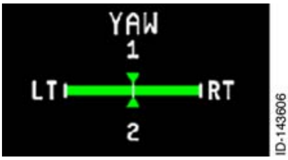
- **Pitch Actuator Indicator** – The pitch actuator annunciator shows the location of the number one and number two pitch actuators. The two arrows (, ) on either side of the bar display the location of the pitch actuator in the vertical plane.



- **Roll Actuator Indicator** – The roll actuator annunciator shows the location of the number one and number two roll actuators. The two arrows (, ) on either side of the bar display the location of the roll actuator in the horizontal plane.



- **Yaw Actuator Indicator** – The yaw actuator annunciator shows the location of the number one and number two yaw actuators. The two arrows (, ) on either side of the bar display the location of the yaw actuator position.



When the aircraft is on the ground and the AFCS preflight test is activated (by pushing the **TEST** button on the autopilot controller), the AFCS synoptic page displays.

In a four DU configuration, when the AFCS preflight test is activated the AFCS synoptic page shows on the pilot MFD. However, the copilot is permitted to select the AFCS synoptic page during AFCS preflight on the copilot MFD. During AFCS preflight test, the AFCS synoptic page shows a text field of AFCS preflight test messages and test status indications. The text field supports show up to six lines of text with 48 characters per line. The AFCS preflight test status indication is displayed in the first line, which is split in two windows of 24 characters each. The left window shows the AFCS one preflight test status indications, and the right window shows the AFCS two preflight test status indications. The AFCS preflight test messages are displayed in the bottom window of five lines of text with 48 characters per line. The AFCS preflight status field is displayed when the AFCS preflight test is running. When the AFCS preflight test is complete, the text fields (with any associated messages) are displayed until they are acknowledged by the pilot by pushing the AFCS test button.

After completion of the test and acknowledgement of the results, the display returns to the display format that was presented prior to activation of the AFCS preflight test.

NOTE: There are some interlock failures that preclude the running of the AFCS preflight test. Those failures are annunciated in the status field until deselected by the pilot. When the preflight is active on an MFD, the **Maintenance** menu option is **grayed** out.

A loss of a valid actuator position information shows an amber X, as shown in Figure 6-21, where the actuator position pointer would normally be located. A loss of valid trim master information shows amber dashes (- - -) in place of the trim master annunciators.

- **Hydraulic Tanks** – Hydraulic tank icons are listed in Table 6-26.

Table 6-26
Hydraulic Tank States

LEVEL/STATE	RESERVOIR GRAPHIC
'22%'	
'28%'	
'50%'	
'100%'	
'UNDETERMINED'	

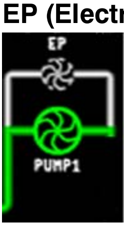
ID-143873

HYDRAULIC PAGE DETAILS

This section describes each element in the Hydraulic page synoptic.

- **Flow Lines** – The flow lines connect various parts of the hydraulic system. The **lines** are green, indicating flow when the line pressure is correct. **Lines** that indicate no flow are gray.

- **EP (Electrical Pump) and L2 Flow Line Icons** – The EP symbol



ID-143884

and the flow line connections are parallel with the HYD PUMP1. The **L2 flow line** is green when both engines are OFF, the left hydraulic pressure is 10 psi, or the pressure is < 10 psi for more than one second. The **flow line** is always green when the electrical pump is ON. When the electrical pump is OFF and there is no flow to **L2,** the flow line is gray. The status of L2 is no flow when the status of the electrical pump is undetermined. L2 is outlined with amber dashes (- - -).

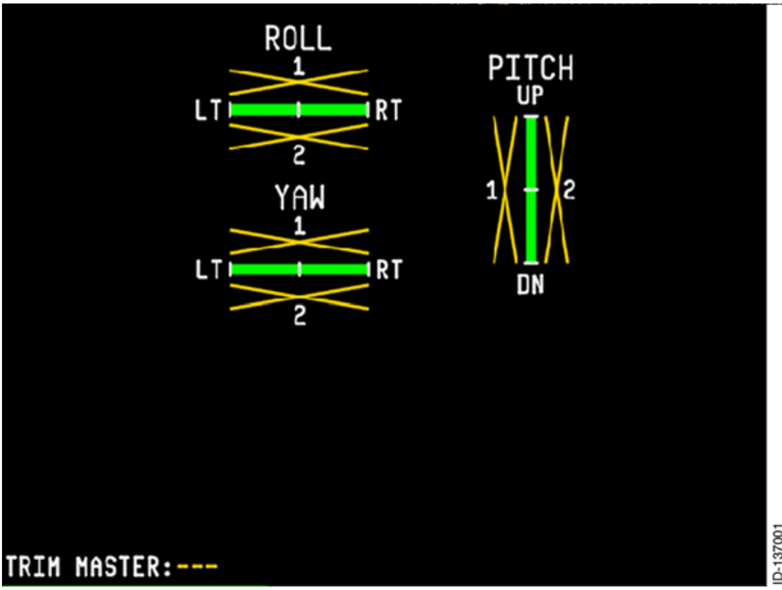


Figure 6-21
AFCS Synoptic Failure

Video Display Window

A video card can be installed, as an option, as an additional card in the MAU. The video card supports display of video from cameras to perform functions such as monitoring parts of the aircraft that the pilot cannot see, or looking behind the aircraft. It supports display of video from mission systems such as a digital map, a gyro stabilized camera or a forward looking infra-red (FLIR) camera. Each video card accepts up to eight video inputs plus a single remote image bus (RIB) input. The video card performs a video switching function to display the selected video source on the MFD. The video card gives two RIB bus outputs. However, the image on each bus are identical. The RIB bus input is given to permit pass-through capability so that multiple RIB video sources are **daisy chained**. The video card accepts NTSC or PAL video inputs and converts this analog video input to the digital RIB bus output format.

When a single video module is installed, the module is located in MAU1 beside Control IO module number one. One RIB output from the single video module is connected to each MFD, therefore, the video source displayed on each MFD is identical. When independent video source selection is required, it is necessary to install a second video module associated with Control IO module number two. When two video modules are installed, the RIB output from each video module is connected to the on-side MFD.

VIDEO MODULE CONFIGURATION

Aircraft personality module (APM) parameters are used to identify the installed camera configuration and control the display of the cameras. The following APM parameters are listed in Table 6-27.

Table 6-27
APM Parameters

APM Parameter Name	Description	Valid States	Default
videoModule1 Installed	Flag for installation of the Video Module 1.	Installed/Not Installed	Not Installed
videoModule2 Installed	Flag for installation of the Video Module 2.	Installed/Not Installed	Not Installed

Table 6-27 (cont)
APM Parameters

numVideosIn Matrix	The number of video sources displayed in the video matrix window.	Min 0 Max 8	0
videoMatrix Labels	Enable or disable display of video source labels on the video matrix page.	Enable/ Disable	Enable
videoMatrixMenu Name	Name for video matrix to be displayed in system menu.	Max 10 characters	Cameras
ribVideoSwitch Installed	Enable or disable the display of a third party RIB video source using RIB video switch to select between the additional source and the CMC.	Enable/ Disable	Disable
ribVideoMenu Name	Text label for menu item to enable display of additional RIB video source.	Max 10 characters	Dig Map
video1Menu	Enable or disable display of the menu item for video source 1.	Enable/ Disable	Disable

Table 6-27 (cont)
APM Parameters

video1Name	Name displayed in system menu for video source 1.	Max 10 characters	Cam 1
video2Menu	Enable or disable display of the menu item for video source 2.	Enable/ Disable	Disable
video2Name	Name displayed in system menu for video source 2.	Max 10 characters	Cam 2
video3Menu	Enable or disable display of the menu item for video source 3.	Enable/ Disable	Disable
video3Name	Name displayed in system menu for video source 3.	Max 10 characters	Cam 3
video4Menu	Enable or disable display of the menu item for video source 4.	Enable/ Disable	Disable
video4Name	Name displayed in system menu for video source 4.	Max 10 characters	Cam 4
video5Menu	Enable or disable display of the menu item for video source 5.	Enable/ Disable	Disable

Table 6-27 (cont)
APM Parameters

video5Name	Name displayed in system menu for video source 5.	Max 10 characters	Cam 5
video6Menu	Enable or disable display of the menu item for video source 6.	Enable/ Disable	Disable
video6Name	Name displayed in system menu for video source 6.	Max 10 characters	Cam 6
video7Menu	Enable or disable display of the menu item for video source 7.	Enable/ Disable	Disable
video7Name	Name displayed in system menu for video source 7.	Max 10 characters	Cam 7
video8Menu	Enable or disable display of the menu item for video source 8.	Enable/ Disable	Disable
video8Name	Name displayed in system menu for video source 8.	Max 10 characters	Cam 8

VIDEO MATRIX PAGE

The video matrix page shows a set of miniature video images. The pilot moves the cursor to toggle between the various images and selects a particular image that is displayed in the full video window. The video matrix is conceptually a matrix of small video windows two columns wide and four rows high, as shown in Figure 6-22.

The following requirements are applicable to the video matrix page.

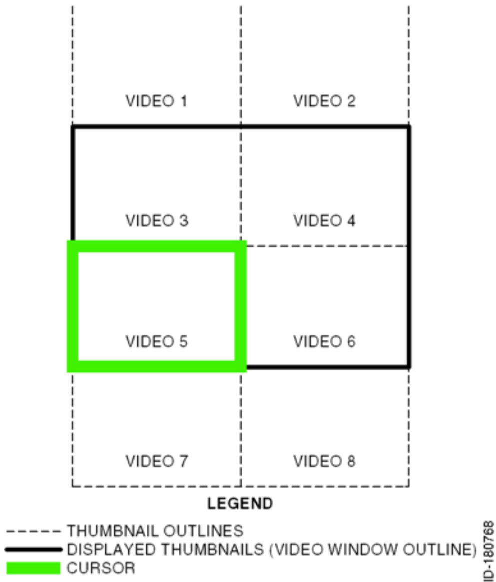


Figure 6-22
Video Matrix

- The video window is split into four smaller windows to enable the simultaneous display of up to four video sources.
- The currently selected video source is highlighted using a green cursor box.
- The cursor is moved using the joystick to highlight any of the video sources that are displayed in the video matrix window.
- When the cursor is located at the bottom of the display window, toggling down moves the display window down on the video matrix page so that the two video sources below the current ones are displayed.

For example, when video sources 1, 2, 3, and 4 are displayed and the cursor is highlighting video source 3, toggling down with the joystick shows video sources 3, 4, 5, and 6.

- Toggling the cursor up on the video matrix page when one of the top two video sources is selected moves the display window up on the video matrix page so that the two video sources above the current ones are displayed.
- When the video window is displaying four video sources, pushing the **ENTER** button zooms into the highlighted video source and shows it as a large image that occupies the entire video window.

  The cursor expands to highlight the entire video window.
- When a single video source is displayed in the large format, pushing the **ENTER** button zooms out to show the same four sources that were displayed prior to zooming in.
- The video matrix window can be exited by using the display select buttons on the CCD. When the video page is exited using the display select buttons, the video matrix window continues to show in the last selected format, but the cursor moves to the MFD menu or PFD as appropriate.

  When another MFD format such as **Map**, **Plan** or **Engine Instruments** is selected, reselecting the **System** menu button redisplays the video matrix or other last selected system menu page format as specified in the Video Module Configuration section.
- When display of video labels are enabled using the APM settings, the text label for each video source is overlaid in small font at the bottom center of the corresponding video window when four video sources are displayed.
- When the large format video display is selected, the text label does not display regardless of the APM setting.
- The number of video sources that are included in the video matrix are controlled using the APM settings.
- When the number of video sources in the matrix is identified as **N**, the matrix shows video sources 1 through N.
- When number of video sources (**N**) is an odd number, the video matrix is displayed as a matrix with N+1 elements, where element number **N+1** is black.

  NOTE: This does not preclude video source N+1 from being displayed using a dedicated system menu item, the MFD does not display in the video matrix display format.

VIDEO DISPLAY CONTROL

The video sources selected for display are controlled using the System Menu on the MFD. The system menu gives menu line items to configure each of the video sources and for the video matrix page. The following requirements are applicable to video display control.

- When the number of video sources in the matrix is set to zero or one, the display of the video matrix menu item does not display.

- When the number of video sources in the video matrix (numVideosInMatrix) is set to two or greater, the MFD **System** menu shows a menu item for the video matrix page. The text of the menu item is defined using an APM parameter (videoMatrixMenuName).

- Selection of the video matrix menu item shows the video matrix page with the last selected video source or sources in view and the cursor highlighted on the previously selected video source.

  When the video matrix page previously displayed the four video sources, the selection of the video matrix menu item displayed the same four video sources. When the video matrix page previously zoomed into a single source, the selection of the video matrix menu item displayed that source in the large format.

- When the APM parameter video(X) menu is set to enable, a menu item is added to the system menu to permit selection of that video source for display.

  Selection of this menu item shows the corresponding video source in large format to occupy the entire video window.

- The text for the menu item is obtained from the corresponding APM parameter video(X) name.

SINGLE VIDEO MODULE AIRCRAFT CONFIGURATION

The following requirements are applicable for single video module configuration.

- When a single video module is installed and video is selected for display on each MFD, the same video image is presented on both displays.

  Video selection by either pilot changes the video display on each MFD.

- When either pilot selects a video source displayed in the main system menu and the other pilot already has a video window displayed, the newly selected video source takes priority and displayed on both MFDs.

DUAL VIDEO MODULE AIRCRAFT CONFIGURATION

When the aircraft is configured with dual video modules, the video sources selected for display on each MFD are independent.

Separate video matrix windows are given for the two pilots so that each pilot can independently browse and zoom in on a video source. Selection of any video source on one MFD has no effect on the video source displayed on the other MFD.

REMOTE IMAGE BUS (RIB) VIDEO SWITCH CONTROL

An APM parameter (ribVideoSwitchInstalled) is given to enable control of a RIB video switch that permits selection of either the central maintenance computer (CMC) video or some other RIB video source given on the RIB. Other RIB video sources can include a digital map system.

The following requirements are applicable for RIB video switch control.

- When RIB video switch control is enabled, an additional menu item is given in the MFD system menu with text defined by the APM parameter ribVideoMenuName.

- Selection of the RIB video switch menu item enables the display of the RIB video in the video window.

- When the aircraft transitions to the air, the control IO outputs a ground state on the RIB video switch discrete output until the **Maintenance** menu item is selected from the **System** menu.

This ensures that the aircraft is in the air and the RIB bus contains information from the other RIB source instead of the CMC.

- Selection of the RIB video switch menu item when the aircraft is on the ground results in a ground set on a discrete output from the control IO module that is used to control the RIB video switch.

  When the aircraft is on the ground, the RIB video switch normally sets to the CMC RIB and the selection of the RIB video switch menu item moves the RIB video switch to some other RIB source (for example, DIGMAP).

- When the aircraft is on the ground, a delay is given between setting the discrete to ground and enabling display of the RIB video in the video window.

Configuration Monitoring Window

The configuration monitoring system, as shown in Figure 6-23, is used to perform automatic monitoring of the hardware and software configuration items that are connected to the avionics standard communication bus (ASCB). When new software or hardware has been loaded in each MAU, a CAS message VALIDATE CONFIG is displayed. To remove the caution message, the pilot selects the **Configuration** window to display the current configuration for verification.

Figure 6-23
Configuration Monitoring Window

In a four DU configuration when the software configuration management system (SCMS) is engaged on one MFD, the MFD shows and controls the configuration monitoring window. The other MFD grays out the menu option to display the page.

Maintenance Window

Selecting the **Maintenance** menu item shows the CMC window. When the maintenance window is selected, the CCD enters a designator mode and the CCD **ENTER** button, joystick, and set knob controls are transmitted to the CCD. The cursor leaves the menu bar and is free to move within the maintenance window.

When one of the display select buttons is selected on the CCD, the CCD exits the designator mode and returns to the normal menu control.

In a four DU configuration, the **Maintenance** menu option is available on the pilots MFD. When the video card (option) or the RIB video switch is installed in the four DU configuration, the first MFD selected for the **Maintenance** interface shows the CMC window and the corresponding CCD controls the interface. The other MFD grays out (unavailable), the **Maintenance** menu selection.

When the RIB video switch is installed, selection of the **Maintenance** menu item results in an open state being set on a discrete output from the control IO module that controls the RIB video switch.

When a single video card is installed, the MFD in which the CMC is not selected for display inhibits selection of any other video source.

In the dual video module configuration, the offside MFD selects any video source and the CMC selection is displayed.

Time/Date Submenu

The **Time/Date** submenu, as shown in Figure 6-24, shows the PRIMUS EPIC real time clock and supports setting of the time and date. When the GPS receiver is valid and is receiving satellite data, the system clock automatically synchronizes with the time and date from the GPS receiver. When the GPS receiver has failed, is not installed or not receiving data, the operator can manually set the system clock using the **Time/Date** submenu, which is controlled using the CCD set knob.

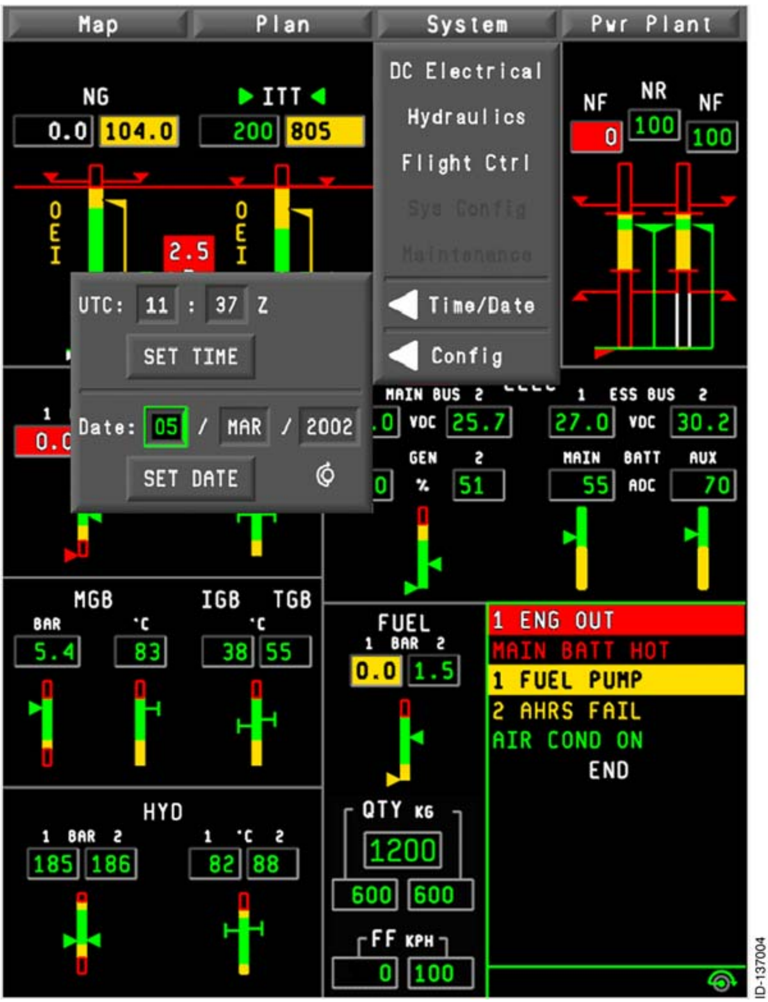


Figure 6-24
MFD Time and Date Submenu

When the system time is synchronized with the GPS, the **SET TIME** and **SET DATE** prompts are displayed in gray to indicate that the operator cannot manually update the time and date.

When the system time and date are not synchronized with the GPS, the operator can manually set them by moving the cursor to the parameter that needs modification. The pilot/copilot rotates the set knob on the CCD to change values and enters it by pushing **Set Time** or **Set Date** as appropriate.

In the four DU configuration, both a pilot and copilot MFD is installed. When one pilot selects the **Time/Date** submenu, the submenu is grayed out on the other MFD.

Config Submenu

The **Config** submenu, as shown in Figure 6-25, is used to select units used for display of fuel related parameters, barometric pressure, and ITT. Changes to the selections are made by using the cursor to highlight the parameter to be configured, and by using the CCD **ENTER** button to toggle between the available states.

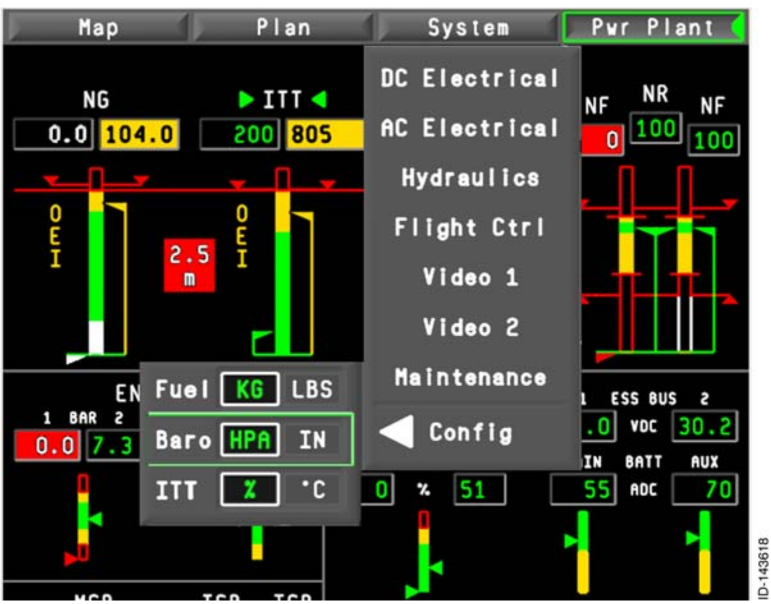


Figure 6-25
Config Submenu

The **Config** submenu permits the pilot to choose between the following units of measure:

- **Fuel** - Kilograms and pounds for the display of fuel related parameters (such as, fuel quantity and flow)
- **Baro (Barometric Pressure)** - Hectopascals and inches of mercury
- **ITT** - % and °C
- **Metric Alt** - When metric altitude is selected for display, a digital readout in meters is displayed above the normal altitude display.

The last pilot-selection of **Config** data is available following system interrupt or shutdown without pilot-resolution.

In the four DU configuration, both a pilot and copilot MFD is installed. When one pilot selects the **Config** submenu, the **submenu** on the other MFD is grayed out.

NAVIGATION DISPLAYS

Map Display

The Map format, as shown in Figure 6-26, shows the flight management system (FMS) flight plan in a Map format.

Figure 6-26
Map Format

Additional data can be overlaid on the map. Data that can be displayed on the map includes:

- Heading display (display referenced to the aircraft heading)
- Heading select
- Flight plan
- Navaids
- Airports
- Identifiers
- Distance to waypoint
- Weather radar overlay and operating modes
- Lightning sensor data
- Traffic alert and collision avoidance system (TCAS) with operating modes
- Terrain alert warning system (TAWS) with operating modes
- Wind
- Drift bug
- Navigation source annunciators
- Lateral deviation display
- Desired track
- Heliports
- TCAS overlay and operating modes
- TAWS overlay and operating modes
- Designator display.

MAP MENU

The **Map** button on the menu bar is used to select and control display of the MFD map format. When the **Map** menu button is highlighted, pushing the **ENTER** button on the CCD shows the map page. Moving the joystick down when the cursor is on the **Map** menu button shows the **Map** drop-down menu, as shown in Figure 6-27.

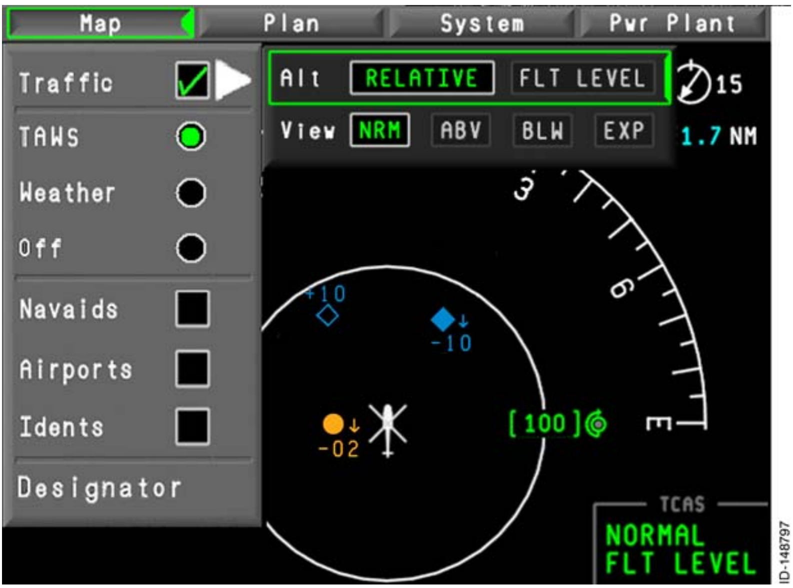


Figure 6-27
Map Menu

The items on the **Map** menu permit various features of the map display to turn ON and OFF. Each menu item includes a check box or a circular button that shows the current status of a display feature. Check boxes indicate display elements that can be turned ON or OFF. A green check mark () shows in a box when that element is turned ON. Circular buttons select mutually exclusive items. The mutually exclusive set of items are grouped together and the selected item is indicated by filling the radio button with a green dot ().

- **Traffic Button** – The **Traffic** button, as shown in Figure 6–28, is selected by highlighting the **Traffic** button and pushing the **ENTER** button on the CCD. Selecting the right arrow button on the CCD joystick when **Traffic** is highlighted on the MAP menu shows the TCAS display configuration menu. The TCAS display configuration menu controls the display of TCAS traffic using relative or absolute altitudes. When absolute altitudes are selected, FLT LEVEL is annunciated. The power–up default for the TCAS target altitude is RELATIVE (relative altitude). When absolute altitude is selected, the setting reverts to the relative state after 15 seconds.

Figure 6–28
Traffic Button With TCAS Submenu

The TCAS display configuration menu is used to select the altitude range for which traffic is displayed using one of the following four ranges:

— NORMAL $\pm$2700 ft
— ABOVE -2700 to +9000 ft
— BELOW -9000 to +2700 ft
— EXPANDED -9000 to +9000 ft.

The power–up default TCAS altitude display range is the NORMAL range.

- **TAWS Button** – When the **TAWS** button is selected, terrain information from the TAWS is displayed on the **Map** page with the flight plan superimposed over the terrain display.

ID-148799

- **Weather Button** – When the **Weather** button is selected, the weather radar image is displayed on the **Map** page with the flight plan superimposed over the radar display.

ID-148800

When the APM parameter indicates that the lightning sensor system (LSS) is installed, the **Weather** menu item changes to **Weather**/**LSS**. Selecting the right arrow button on the CCD joystick when the **Weather**/**LSS** item is highlighted on the **MAP** menu shows the LSS submenu. The LSS submenu contains the **LSS CLR** button to erase all memory of past strikes and the **LSS** button with a check box to control the display of lightning strikes.

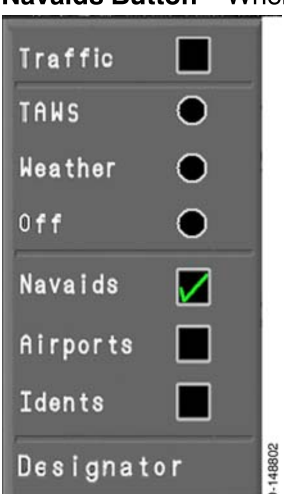
Pushing the **ENTER** button on the CCD when the **LSS** button is highlighted and when the **Weather**/**LSS** menu item is selected toggles the display of lightning strike information on the MFD ON and OFF.

The power-on default for the LSS enables the display to permit lightning strikes.

NOTE: Selection of **TAWS** and **Weather**/**LSS** are mutually exclusive. When **Weather**/**LSS** is selected and TAWS is already selected, the **TAWS** button is deselected. Likewise, when TAWS is selected and weather is displayed, **Weather**/**LSS** is deselected.

- **Off Button** - When the **Off** button is selected, Weather and TAWS are not selected.

- **Navaids Button** - When the **Navaids** button is checked, the MAP page shows the location and identifiers for navigation aids located within the MAP range.



- **Airports Button** – When the **Airports** button is checked, the MAP page shows the location and identifiers for airports located within the MAP range.

- **Idents Button** – When the **Idents** button is checked, the MAP page shows an identifier adjacent to any flight plan waypoint symbols shown on the display.

- **Designator Button** – Selecting the **Designator** menu item using the **ENTER** button on the CCD activates the designator mode on the **Map** page.

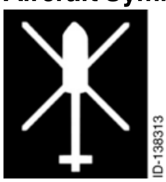
NOTES:

1. Traffic, Navaids, Airports, and Idents can all be displayed at the same time.
2. The **TAWS**, **Weather**, and **TCAS** menu items are removed when the aircraft personality module (APM) parameters indicate that they are not installed. When TCAS is not installed, the TCAS menu item is not displayed, similarly when TAWS or weather radar is not installed, the corresponding menu item is not displayed.
3. When APM parameters indicate that weather radar is not installed and LSS is installed, the **Weather** menu item is replaced by **LSS** and the LSS submenu includes the **LSS CLR** button. The other submenu is not needed as the **LSS** button on the main menu is used to toggle the display of lightning strike information on the MFD **On** and **Off**. Selection of TAWS and LSS is mutually exclusive when LSS is installed (weather radar is not installed).
4. When one of the **TAWS** and **Weather**/**LSS** menu items are enabled for display, the remaining item is displayed on the menu with a check box in place of the radio button. The dividing line used to group the **TAWS** and **Weather**/**LSS** menu items is removed when one of these items is enabled for display.

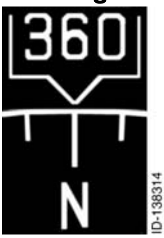
DISPLAY ELEMENTS

The MFD map heading compass scale is an arc display that consists of rising $\pm 90°$ from the top-center of the dial. A long tick mark is displayed every 10°. A short tick mark is displayed at each intermediate 5° point. Each 30° tick mark is labeled with characters, N, 3, 6, E, 12, 15, S, 21, 24, W, 30, 33.

- **Aircraft Symbol** – A fixed aircraft symbol is displayed at the center of the compass arc as an aid to visualize the actual position of the aircraft in relation to horizontal navigation information being displayed.



- **Heading and Digital Readout** – The aircraft heading is indicated



by movement of the compass rose with respect to the lubber mark at the top of the compass. Left turns rotate the compass rose clockwise. Right turns rotate the compass rose counterclockwise.

A digital readout of heading is located in a partial box at the top of the heading lubber line. The bottom portion of the box is notched to fit in the heading notch. Heading information is furnished for display by the AHRS.

When valid heading information from the AHRS is lost, all tick mark labels (such as, cardinal points like W and numerical points such as 33) are removed from the display, and HDG FAIL is annunciated at the top of the compass arc. The heading bug is removed and the digital heading readout shows amber dashes (- - -).

When heading is reported in test mode from the selected source, a HDG TEST annunciator is displayed on the top of the compass arc.

- **Heading Source** – The heading source annunciator is displayed

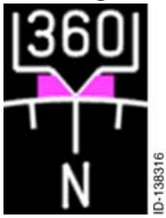
above and to the right of the digital heading readout box. When the normal on-side heading source is displayed, no source annunciator is displayed unless the directional gyro (DG) mode has been selected. When the DG mode is selected, DG 2 is displayed on the pilot MFD or DG 1 is displayed on the copilot MFD.

Heading source information is selected using the on-side display controller. When the ATT/HDG1 reversion is selected, MAG1 or DG 1 is displayed on the configured MFD(s). When ATT/HDG2 reversion is selected, MAG2 or DG 2 is displayed. When crew sources are cross-side, MAG2 or DG 2 is displayed on their respective MFD.

NOTES: 1. The AW139/AB139 source selection controls do not support both pilots selecting the cross-side source. The heading source is annunciated when both pilots have the same source selected or when the DG mode is selected.

2. The heading source annunciator is not removed for failure.

- **Heading Select Bug** – The heading select bug is set from the display control function. The selected heading is displayed on a heading bug that travels 360° along the outer edge of the compass card. An associated digital readout with a HDG label is displayed full time in the upper right corner of the display. The bug is cyan when the flight director is not coupled, and it is magenta when the flight director is coupled. The color of the heading bug and heading bug digital readout are always the same color.



The example above shows the heading indicator lubber mark is resting in the triangular notch of the heading bug indicating the actual heading and the selected heading of the aircraft is 360°.

The heading select knob of the remote instrument controller (RIC) changes the position of the heading bug on the perimeter of the compass rose. When the flight director is in heading select mode, commands are generated that align and maintain the aircraft on the heading selected by the bug.

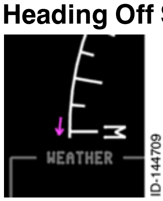
- **Yaw Heading Hold Reference Bug** – The yaw heading hold reference bug is shown on the HSI heading scale tape when the flight director indicates the yaw heading hold is functional.

The yaw heading hold reference bug is shaped as a notched rectangle, but is smaller than the heading select bug. The set point is determined by the priority autopilot.

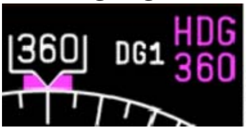
The yaw heading hold reference bug has visual priority over the heading select bug. Both the yaw heading hold reference bug and the heading select bug can be displayed simultaneously. The visual priority ensures the heading select bug does not completely mask the yaw heading hold reference bug.

A loss of valid heading information from the AHRS or a loss of valid yaw heading hold reference information from the priority autopilot removes the yaw heading hold bug.

- **Heading Off Scale Arrows** – The heading bug can go out of view. When the bug goes out of view, an arrow pointing to the shortest direction to the bug is displayed above the compass arc. The arrow is removed when the bug comes into view. The arrow is cyan ← when the flight director is not coupled and magenta ← when it is coupled.



- **Heading Digital Readout** – The heading digital readout, positioned to the right of the heading indicator, shows the heading indicated by the bug. The heading bug and digital readout are magenta, alerting the pilot that the flight director heading select mode is engaged and reliable. The lubber point of the heading indicator is aligned in the notch of the magenta heading bug indicating the aircraft is maintained by the flight director on a selected course of 360°.

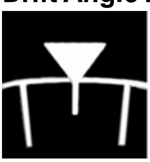


ID-138319

The cyan reference bug, digital readout, and HDG label, alert the pilot that the flight director heading mode is not engaged.

ID-138320

- **Drift Angle Pointer** – The white, triangular, drift angle pointer is shown at left. The position of the pointer is set by the FMS. It is displayed on the outside of the compass arc to indicate ground track angle necessary to maintain course. When valid heading information from the AHRS or valid track angle information from the FMS is lost, the drift bug is removed.


ID-138321

- **Map Range Display** – A half-range ring is located an equal distance between the outer heading/range compass arc and the arc center. The half-range ring is labeled with the correct range value (1/2 of **WX** range or 1/2 of display control range when WX is not displayed/invalid). When either cursor is on the MFD, the map range can be controlled using the outer set knob of the CCD. Green brackets are placed around the range display to indicate that it is controlled by the CCD. A curl symbol highlighting the outer knob is displayed adjacent to the map range to indicate which set knob is used to control the range.

ID-143615

When valid range information from the display control function is lost, amber dashes (- - -) replace the range label. However, the half-range ring is not removed.

- **Navigation Source** – The navigation source is annunciated in the upper left corner of the display as selected by the pilot display control function. When the FMS is not coupled to the flight director, the navigation sources are FMS1 or FMS2 for dual FMS systems. The navigation source annunciator is FMS for a single FMS system. When the FMS is coupled to the flight director, the navigation sources are FMS1 or FMS2 for dual FMS systems. The navigation source annunciator is FMS for a single FMS system.

  FMS1 or FMS2 is annunciated when in display reversion or the pilot and copilot both select cross-side, or same.

  A loss of valid data from the FMS results in the NM navigation source displaying amber dashes (- - -).

- **Desired Track** – A digital readout of the desired track is displayed above and to the left of the HSI just below the navigation source identifier. The digits are cyan when the FMS is not coupled to the flight director, magenta when the FMS is coupled to the flight director.

  A loss of valid heading information from the AHRS, or loss of information from the displayed FMS shows amber dashes (- - -).

- **Estimated Time En Route (ETE)** – The estimated time en route to the TO waypoint is displayed in the upper right corner of the page. The ETE displayed is from the selected FMS. The ETE display line is labeled ETE preceded by the ETE value readout. For ETE less than one hour, the ETE shows as two digits. For ETE equal to or greater than one hour, the ETE shows as hours and minutes (such as, H+MM). The maximum displayable ETE is 9 hours and 59 minutes (9+59).

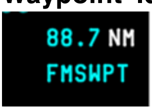
  

  The digits are cyan when the FMS is not coupled to the flight director and magenta when the FMS is coupled to the flight director. An invalid ETE readout is replaced with amber dashes (- - -).

- **TO Waypoint Distance Readout** - The TO waypoint distance readout is displayed in the upper right corner of the display below the ETE display. The waypoint distance displayed is from the selected FMS. The distance digital readout range is 999 NM for the FMS. From 0-99.9 NM, the information is rounded to the nearest 0.1 NM and the resolution is 0.1 NM. For distances greater than 99.9 NM, the information is rounded to the nearest 1 NM and the resolution of the display is 1 NM. The digital readout is labeled with the units **NM**.

  The digits are cyan when the FMS is **not coupled** to the flight director and magenta when the FMS is **coupled** to the flight director. An invalid distance readout is replaced with amber dashes (**- - -**).

- **Waypoint Identifier** - The current fly-to waypoint identifier is

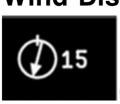
  

  ID-143613

  displayed in the upper right corner of the display. The waypoint identifier displayed comes from the selected FMS. The waypoint identifier toggles reverse video when a waypoint sequencing alert condition is active.

  The digits are cyan when the FMS is **not coupled** to the flight director and magenta when the FMS is **coupled** to the flight director. The inverse video for these two conditions are **cyan** and **magenta**. The identifier is removed from the display when the valid waypoint identification from the FMS is lost.

- **Wind Display** - The wind display shows the wind direction as a

  ID-143616

  vector enclosed in a miniature compass rose. Wind speed is displayed adjacent to the vector and is rounded to the nearest 1 knot. The wind display is suppressed when displayed wind speed is zero. The **wind display** is always white.

  When wind data is lost, the display is removed. When the FMS indicates data as stale, or **no computed data**, the **wind display** turns amber. When the FMS data is displayed against a magnetic heading display, it compensates for magnetic variation. The magnetic variation for correcting the FMS data is displayed on the FMS. The parameters on the MFD compass which must be compensated for are desired track, bearing, and drift angle. When the FMS is not the displayed source, drift angle compensates for magnetic variation by using the FMS.

Flight Plan Data

The FMS flight plan is displayed on the MFD when the FMS is selected. Flight plan waypoints, NAVAIDS and airports are transmitted by the selected FMS. Selection is made individually or in any combination of the three. Flight plan symbols are displayed, as shown in Figure 6-29.

Figure 6-29
Flight Plan on Map Page

The display format can display waypoints received from the FMS. A waypoint position is defined by the latitudinal and longitudinal position with respect to the present position, heading, and map scale. When the display of identifiers is turned on using the **Map** menu, the waypoint identifiers are shown on the map. The waypoint is labeled to the right with an identifier of up to six characters in length. Track lines connect the active waypoints of the flight plan with their successor waypoint as long as the current waypoint is not followed by a discontinuity and the successor waypoint is valid.

The **TO waypoint** is magenta when the FMS is coupled to the flight director and the **TO waypoint** is cyan when the FMS is not coupled. The **FROM** waypoint is always yellow and all other waypoints in the flight plan are white. The waypoints utilize the color of the track lines.

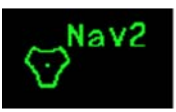
Waypoints that have an identifier or symbol associated with it are displayed. When a waypoint is a transition point that has no identifier or symbol, the waypoint is not displayed. Only waypoints that are part of the primary flight plan are displayed. TOC, TOD, and (BOSC) waypoints are displayed without altitude information.

Waypoint symbols do not display when a loss of valid heading information from the AHRS or a loss of valid waypoint information from the FMS occurs. When a waypoint is invalid that waypoint is removed.

NAVAIDS

NAVAIDs are displayed by selecting **Navaids** on the **Map** drop-down menu bar. The display presents the NAVAID symbols for all NAVAIDs transmitted by the FMS in the FS/EFIS buffer on the ASCB. The display generates a list of the 10 closest NAVAIDs to the current aircraft position. The NAVAID location is based on its latitude and longitudinal position with respect to the present position, heading, and MAP scale. When display of the identifiers are turned on using the **Map** menu, the NAVAID is labeled to the right with an identifier up to four characters in length.

- **DME**



ID-124813

- **NDB**

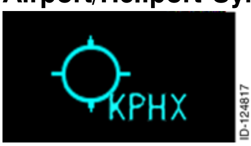
ID-124815

- **VOR**

- **VOR/DME**

The loss of valid heading information from the AHRS, or a loss of valid NAVAID information from the FMS removes all NAVAID symbols. When one NAVAID is invalid by the FMS, that NAVAID and identifier are removed from the display.

- **Airport/Heliport Symbol** – **Airports and heliports** are always displayed in cyan. They are selected for display on the **Map** drop-down menu bar. The display presents a list of the closest 10 airports and 10 heliports. The airport/heliport locations on the MFD are based on their latitudinal and longitudinal position with respect to the present position, heading, and MAP scale. The airport symbol is labeled to the right with an identifier up to four characters in length.



When valid heading information from the AHRS or a loss of valid airport information from FMS is lost, all airport and heliport symbols are removed from the display. When one airport/heliport is invalid, that airport/heliport is removed.

- **Map Mode Flight Path Vectors** – Vectors are derived from the FMS as part of the FMS map background data. The vectors are used to show continuity of the flight plan between waypoints.

ID-148882

  Vectors are positioned on the display with respect to the current aircraft location and heading, using the present position, vector position (entry latitude/longitude and exit latitude/longitude), current heading and the selected map range. Flight path vectors from the FROM waypoint to the TO waypoint are magenta when the FMS is coupled to the flight director, and the TO waypoint is cyan when the FMS is not coupled. All other vectors are white.

  The vectors are displayed in the same color as the waypoint that terminates the vector. The vectors can represent an active flight plan (solid white or magenta or cyan lines) or a modified route (dashed white - - - lines).

- **Altitude Profile Points** – An altitude profile point presents the location of specific altitude transition points on the lateral flight plan. These points include top-of-climb (TOC), top-of-descent (TOD), bottom-of-descent (BOD) and bottom-of-step climb (BOSC). These symbols are displayed on the flight plan. The altitude profile point identification is up to four alphabetic characters.

ID-124819

- **Holding Patterns** – The holding pattern symbol is racetrack shaped. It is displayed at the appropriate waypoint as transmitted by the FMS. The leg length, turn radius, and inbound course data required to draw the holding pattern are transmitted by the FMS. The racetrack symbol is drawn to scale and it changes in size as appropriate with Map range changes.


ID-124820

  When valid heading information from AHRS or valid information from FMS is lost, the holding pattern symbol is removed from the display.

The flight plan leg display color scheme is listed in Table 6-28.

Table 6-28
NAV Source Color Scheme

Color	Condition
Cyan	Flight plan leg for current fly TO waypoint when the FMS is not coupled to the flight director.
Magenta	Flight plan leg for current fly TO waypoint when the FMS is coupled with the flight director.
White	Flight plan leg for nonfly TO waypoint.

- **Procedure Turns** – A procedure turn symbol is displayed where the location of a procedure turn is within the flight plan. Procedure turns are positioned on the display with respect to the current aircraft location and heading.

- **Lateral Deviation Display** – A digital readout of the FMS lateral deviation is displayed in the lower portion of the map display. The digits are cyan when the FMS is **not coupled** to the flight director and magenta when the FMS is **coupled** to the flight director.

  The format deviation is miles followed by an **L** for when left of course (positive distances) or an **R** label when right of course (negative distances). A typical readout is **1.5 R**. For distances equal to zero miles, no label is displayed. The distance is rounded to the nearest .01 mile up to .99 miles and to the nearest .1 mile from 1.0 miles up to 99.9 miles. Greater than 99.9 miles, the display is rounded to the nearest mile.

  A loss of valid heading information from the AHRS or valid flight plan information from the FMS removes the lateral deviation display.

TCAS Display

Terrain alert and collision avoidance system (TCAS), as shown in Figure 6-30, is set up and displayed by selecting **Traffic** on the MFD pull-down menu, as described in the previous paragraphs.

Figure 6-30
TCAS Display

TCAS DISPLAY SYMBOLS

There are three types of traffic symbols used in the TCAS traffic display. Each symbol is based on the level of threat to the aircraft.

- **Traffic Advisory (TA) Level** - The TA symbol depicts targets that are classified as traffic advisories by the TCAS computer. The TA is displayed as a circular, solid, amber shaped symbol (). The TA symbol is positioned to depict a threat from other aircraft relative to bearing and distance from the helicopter. TA targets that are off scale are indicated by placing one half of the symbol at the edge of the active display area. A loss of valid information from the TCAS removes the TA symbols.

- **Proximate Traffic (PT)** – The PT symbol depicts targets that are classified as proximate traffic by the TCAS computer. The PT is displayed as a diamond, solid, cyan shaped symbol (◆). The PT symbol is positioned to depict a threat from other aircraft relative to bearing and distance from the helicopter. PT targets that are beyond the displayed range are removed from the display. A loss of valid information from the TCAS removes the PT symbols.

- **Other Traffic (OT)** – The OT symbol depicts other non-threat aircraft. The OT is displayed as a diamond, empty, cyan shaped symbol (◇). The OT symbol is positioned to depict relative bearing and distance of other aircraft from the helicopter. OT targets that are beyond the displayed range are removed from the display. A loss of valid information from the TCAS removes the OT symbols.

- **Intruder Vertical Speed Indication** – The TCAS computer

monitors the vertical speed of traffic within the helicopter vicinity and filters the information into traffic with vertical speeds. Traffic with vertical speeds greater than or equal to 500 FPM have a vertical arrow located directly to the right of the corresponding traffic symbol. The arrow points down for descending traffic and up for ascending traffic. The color of the arrow matches that of the corresponding traffic symbol. A loss of valid vertical speed indication from the TCAS removes the vertical speed arrows.

- **Intruder Relative Altitude Display** – When relative altitude of an

intruding aircraft is available, a data tag indicating relative altitude is displayed with the corresponding traffic symbol. The data tag is centered above the traffic symbol preceded with a **+** when the intruder aircraft is above the helicopter altitude and centered below the traffic symbol preceded with a **–** when the intruder aircraft is below the helicopter altitude. When the intruder is at the helicopter altitude, the data tag centers above the symbol without any polarity sign. The relative altitude data tag consists of two digits indicating hundreds of feet. The color of the relative altitude data tag matches the color of the corresponding traffic symbol. A loss of valid relative altitude from the TCAS removes the relative altitude data tag.

- **Intruder Absolute Altitude Display** – The flight level (absolute altitude) of an intruding aircraft shows in place of the relative altitude when selected from the MAP drop-down menu using the CCD. The electronic display system (EDS) calculates the absolute altitude by adding the relative altitude given by the TCAS computer to the barometric altitude of the helicopter.

  Absolute altitude consists of three digits indicating hundreds of feet. Leading zeros are displayed and the displayed value is rounded to the nearest 100 feet. Absolute altitude is replaced with relative altitude when a TA condition is encountered. The color of the absolute altitude data tag matches the color of the corresponding traffic symbol. The EDS resets this selection to relative altitude display after 15 seconds. When absolute altitude is selected, the FLT LEVEL annunciator is located in the TCAS status window. A loss of valid barometric altitude information from the ADS shows relative altitude information.

- **No Bearing Target Readout** – When a TA target is encountered that does not have a bearing available for display, the information for that target is displayed in text. The data uses two text lines located above the TCAS status window. The first line contains data for the highest priority no-bearing-target and the second line contains data for the second highest priority no-bearing-target. The TCAS no-bearing-target data follows the subsequent format:

  — Type = TA

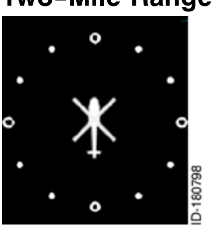
  — Range = Range to target from helicopter

  — Relative Altitude = Altitude difference

  — ⇓/⇑ – Direction of vertical rate of target (≥500 FPM).

  Example: A target creating a TA at 1.2 NM, 600 feet below the helicopter and climbing ≥500 FPM = TA 1.2 -600↑.

- **Two-Mile Range Ring** – When traffic information is selected for display on the MFD from the **Map** drop-down menu bar, a ring of twelve small circles (or dots) are placed in a radius of two nautical miles around the helicopter symbol. The dots are arranged so that one dot is placed at each of the clock hour positions, with the helicopter symbol heading at twelve o'clock. The two-mile range ring is displayed proportional to the current MFD range selection. When the MFD range is ≥25 NM, the range ring is removed. A loss of valid TCAS information and valid heading information from the AHRS removes the two-mile range ring.

- **Above/Below/Normal Target Filtering** – The EDS is responsible for filtering TCAS targets according to relative altitude limits selected from the MAP drop-down menu. The limits are expressed as altitudes relative to the present aircraft altitude.

  When the normal TCAS display mode is selected, the EDS shows other traffic (OT) symbols between ±2700 feet relative altitude and a NORMAL annunciator is displayed in the TCAS window.

  When above mode is selected, the EDS shows other traffic (OT) symbols from -2700 feet to +9000 feet relative altitude and a ABOVE annunciator is displayed in the TCAS status window.

  When below mode is selected, the EDS shows other traffic (OT) symbols from +2700 feet to -9000 feet relative altitude and a BELOW annunciator is displayed in the TCAS status window.

  When expanded (unrestricted) is selected, the EDS shows other traffic (OT) symbols from ±9000 feet relative altitude and an EXPANDED annunciator is displayed in the TCAS status window.

  In the four-display configuration where each MFD is present, the setting for target filtering is applied on the display where the filtering was set. The other MFD independently sets the target filtering state. The current MFD TCAS target filtering state transmits on the avionics standard communication bus (ASCB) for use by the flight data recorder (FDR).

  A loss of valid attitude select mode information from the TCAS reverts the unit to normal mode with all target symbols displayed between ±2700 feet relative altitude.

TCAS STATUS WINDOW

A TCAS status window, as shown in Figure 6-30, appears in the lower right corner of the MFD MAP window when a TCAS is installed in the aircraft. Display of this window is enabled using the TCAS installed APM parameter. The TCAS status window gives the following indications.

- The TCAS target filtering status is indicated using the NORMAL, ABOVE, BELOW or EXPANDED annunciators.
- When absolute altitude display mode is selected for TCAS targets, the FLT LEVEL annunciator is displayed.
- When TCAS indicates a functional test, a TCAS TEST annunciator is displayed in amber.

- When TCAS is valid, or in a functional test and TCAS indicates standby, a TCAS OFF annunciator is displayed.
- When the following conditions are present, a TCAS FAIL annunciator is displayed.
  - TCAS bus fails
  - TCAS indicates TCAS system failure
  - TCAS control word indicates failure or no computed data
  - TCAS computer fails.

The TCAS status annunciators are displayed in a single field using the following priority from highest to lowest TCAS TEST, TCAS OFF, TCAS FAIL and TCAS filtering status.

Weather Data

Weather is selected on the MFD pull-down by selecting the **Weather** button.

WEATHER STATUS WINDOW (OPTION)

When the weather radar is turned ON, the weather sensor status window is displayed in the lower left corner of the main MFD window when the Map page is selected The window is identified by the off-white header WEATHER as shown in Figure 6-31.

Figure 6-31
Weather Status Window

The WX mode annunciators are displayed on the top line of the weather window. The mode annunciators are white when they are not selected for display, green when selected for display, and amber when flashing. FSTBY and FAIL are always amber when they are displayed.

Mode annunciators for P-660 radar are:

- WAIT
- STBY
- FSTBY
- TEST
- WX
- WX/T
- WX/RCT
- WX/R/T
- GMAP
- FPLN
- FAIL.

The mode annunciators for P-700/701 radar are:

- WAIT
- STBY
- FSTBY
- TEST
- WX
- WX/T
- WX/RCT
- WX/R/T
- WX/GCR
- GMP1
- GMP2
- GMP1/SCR
- GMP1/CR1
- GMP1/CR2
- ROC
- BCN
- FAIL.

The WX mode annunciator toggles reverse video when any of the following conditions are met:

- The WX mode is WAIT.
- For P-660 radar: A transmitting mode is active (TEST, WX, WX/T, WX/RCT, WX/GCR, GMAP) and the aircraft is on the ground.
- For P-700/701 radar: A transmitting mode is active (TEST, WX, WX/T, WX/RCT, WX/R/T, WX/GCR, GMP1, GMP2, GMP1/SCR, GMP1/CR1, GMP1/CR2, ROC) and the aircraft is on the ground.

One WX mode annunciator displays at any time using the following priority scheme:

- For P-660 radar:
  - Priority 1 (highest) - FAIL
  - Priority 2 - WAIT
  - Priority 3 - FSTBY
  - Priority 4 - All other annunciators
- For P-700/701 radar:
  - Priority 1 (highest) - FAIL
  - Priority 2 - All other annunciators.

The WX mode annunciator is replaced with a WX /OFF annunciator when the radar is in the OFF mode.

- **Tilt Setting** - Weather radar antenna tilt setting data is displayed on the second line of the WX mode annunciators. The tilt data is displayed to a .5° resolution for tilt angles between ±10°, and to a 1° resolution for angles ±10°. The data is preceded by a **T**. The data is followed with an arrow that points up for positive angles and points down for negative angles (such as, T7.5↑ for seven and a half tilt up). The tilt angle data is limited to ±15° The data is followed with a green A label when the autotilt function is active (such as, T7.5↑ A).
- **Target Alert/Variable Gain** - The target alert mode annunciator and the variable gain indicator are displayed on the fourth line of the weather window directly below the STAB annunciator. One annunciator is displayed at a time with the target alert mode annunciator having priority over the variable gain indicator. When target alert mode is selected, a TGT annunciator is displayed. When the radar detects an alert condition, the TGT toggles to TGT and back as long as the condition persists.

For P-660 radar, variable gain indication is displayed as a digital readout of knob rotation when the variable gain mode has been selected. The indication is in the format of G 75%, meaning gain is at 75%. Full counterclockwise position of the knob corresponds to 0% and full clockwise position of the knob corresponds to 100%.

The P700 radar variable gain indication is displayed as a VGN annunciator.

- **Restricted WX Operating Conditions** - The following mode selection combinations are restricted.

  — Variable gain is not active with GCR, RCT, or TGT. GCR, RCT, and TGT have priority over variable gain.

  — RCT is not active with GCR. GCR has priority over RCT.

  — GCR is not active with turbulence. Turbulence has priority over GCR.

  — Turbulence, RCT, or TGT is not active with GMAP. GMAP has priority over turbulence.

  — GCR or turbulence is not active in ranges > 50 NM and TGT is not active in ranges $\geq$ 300 NM.

  NOTE: The PRIMUS 660 radar does not support turbulence, references to turbulence refers to the PRIMUS 880 radar or P-700/701 radar.

- **Stabilization Mode Annunciator** – When the radar stabilization is OFF, a STAB annunciator is on the third line of the weather window directly below the tilt display.

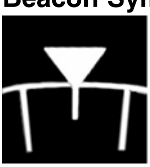
- **Combination of Weather and TAWS Window** - When weather radar is active (turned on) and TAWS is selected for display, a combination of weather and TAWS windows show. The weather window consists of two lines, top line for WX mode annunciators and bottom line for target alert/variable gain display. The TAWS window includes two lines of information.

  Indication of internal failure from the weather radar replaces the mode annunciator with an amber FAIL. When the radar is ON and the serial bus is inactive, the mode annunciator is replaced with an amber WX annunciator. When the range is commanded by the CCD and the WX does not respond with the requested range, the range value is annunciated in amber text for six seconds before returning to the previous range setting. A weather radar BUS failure is annunciated with an amber WX on the MFD range ring.

BEACON WINDOW AND SYMBOL (OPTION)

When beacon mode has been selected for the P-700/701 radar, a beacon window is displayed in the lower portion of the MFD with the **BEACON** label depicted in gray. The beacon window shares the same space as the designator window with the designator window having priority. This window shows the beacon type, beacon code, beacon gain, beacon range, and bearing.

- **Beacon Type** - Beacon type is displayed as **1P**, **2P**, or **6P** for monopulse, 2-pulse or 6-pulse beacon respectively.
- **Beacon Code** - Beacon code is displayed to the right of beacon type when beacon type is 2-pulse or 6-pulse. It is represented with two characters using a leading zero when appropriate.
- **Beacon Gain** - When variable gain is selected for beacon mode, a green **V** is displayed to the right of the beacon code. When auto gain is selected for beacon mode, an amber **A** is displayed to the right of the beacon code. The selection of auto or variable gain is mutually exclusive.
- **Beacon Range** - The beacon range readout rounds to a resolution of 0.1 NM when range is less than 100 NM and to 1.0 NM when range is greater than or equal to 100 NM. The beacon range readout is labeled with a white **NM** abbreviation for nautical miles. When the beacon position is invalid by the weather radar, the beacon range is removed.
- **Bearing** - The magnetic beacon bearing digital readout uses three digits rounded to the nearest degree and is labeled with a degree symbol. The bearing readout is padded with the leading edge zeros when the bearing is less than 100 degrees. When the beacon position is indicated as invalid by the weather radar, the magnetic bearing readout is replaced with amber dashes (**- - -**) .
- **Beacon Symbol** - A beacon symbol represented by a filled white triangle is displayed on the map using the beacon range, magnetic bearing, and map range when beacon mode is active. The beacon position must be valid and weather radar is selected for display. The beacon symbol rotates by magnetic bearing so that the base is perpendicular to the magnetic bearing. A loss of valid heading information or valid beacon position removes the beacon symbol from the display.



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WEATHER RADAR DISPLAY (OPTION)

Weather radar (WX) returns are displayed, as shown in Figure 6-32, when they are selected for display from the MAP drop-down menu bar using the CCD.

Figure 6-32
MFD Displaying Flight Plan, Weather and Lightning Returns

As an indication that the WX returns have been selected for display, the weather radar display sector is indicated by tick marks on the half-range ring. The left and right position of the tick marks are at ±60°, referenced to the current heading. When the WX system is operating in the sector scan mode, the left and right tick mark positions are at ±30°, referenced to the current heading. The portion of the half-range ring between the tick marks are dashed to give further indication of the display sector.

The MFD WX format colors are consistent with standard WX returns listed in Table 6-29.

Table 6-29
Rainfall Rate Color Cross Reference

Color	Rainfall Rate (inches/hr)	Rainfall Rate (mm/hr)
Green	.04-.16	1-4
Amber	.16-.47	4-12
Red	.47-2	12-50
Magenta	Greater than 2	Greater than 50
Cyan	react mode	
Dim White	Turbulence	

The MFD GMAP format uses colors listed in Table 6-30.

Table 6-30
Ground Mapping Color Cross Reference

Color	Level
Cyan	Level 1 returns
Amber	Level 2 returns
Magenta	Level 3 returns

NOTE: When WX erase is indicated, the WX returns are erased before screen updates continue.

LIGHTNING SENSOR SYSTEM MODES AND ANNUNCIATORS (OPTION)

When the APM parameter indicates that LSS is installed, the weather window expands to add a line to the bottom of the window. The lightning sensor system mode annunciator is displayed in the last line of the weather window.

NOTE: When the APM parameters indicate that the LSS is installed and weather radar is not installed, the weather window has one line for LSS mode annunciators.

The weather sensor status window for LSS annunciators are displayed in the lower left corner of the Map page when the APM parameter indicates that the LSS is installed.

When both weather radar and LSS are installed, but WX annunciators are not displayed, the weather window has one line for LSS mode annunciators. The weather window expands to four lines when WX annunciators need to be displayed.

The LSS mode annunciators are listed in Table 6-31, along with the annunciator color and enabling signal. Annunciators are prioritized in the order with LX having the highest priority.

Table 6-31
Lightning Sensor Modes

LSS MODE	Annunciator Mode	Signal
LSS Interface Failure	LX	Note 1
Fault Code Display	LX mn	LX Fault Code
LSS Fault Detected	LX/FAIL	LX Fault
Standby Mode	LX/STBY	When LSS is not selected for display
Clear Mode	LX/CLEAR	LX Clear
Test Mode	LX/TEST	LX Test Mode
Antenna Input Inhibited	LX/INHIB	LX Ant Inhib
Heading Input Deselected	LX/HDG	LX Hdg Invalid
Self Calibration Mode	LX/CAL	LX Auto Cal
Normal Operation Mode	LX	LX Normal

NOTE: Activated when the LSS is ON (LX Power) and the ARINC 429 bus is inactive.

LIGHTNING SENSOR SYSTEM CONTROL DISCRETES

The EDS outputs two commands to CSIO by way of the ASCB and the CSIO transmits them by way of discretes to the LSS processor. These discretes are used to control the LSS modes and one of them is used for activating the CLEAR/TST function of the LSS and the other one is used to put LSS in normal mode.

The LSS CLR/TST mode is mutually exclusive with the LSS normal mode and when the CLEAR/TST discrete is set to low, the LSS normal mode discrete is set to high and vice-versa.

LSS STRIKE DISPLAY (OPTION)

Lightning (LX) data from the LSS is displayed when the LSS power is ON. The MFD shows up to 16 strikes, three of which can be alerts. The number of symbols actually displayed are indicated by an LX strike count, as shown in Figure 6-33.

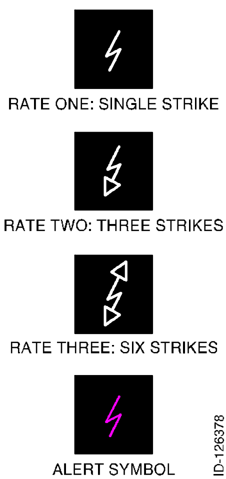


Figure 6-33
Rate-of-Occurrence Symbols

The lightning symbol is displayed at a position based on the LX strike bearing and the LX strike distance. When an LX strike intensity shows an alert, the lightning symbol is displayed at the maximum display range at the proper LX strike bearing.

A loss of valid lightning information from the LSS removes the lightning symbols.

Terrain Alert Warning System (TAWS) Data

The TAWS data can be displayed by selecting the **TAWS** button on the MFD pull-down menu.

The TAWS system, as shown in Figure 6-34, is described in detail in Section 19, Terrain Alert Warning System.

Figure 6-34
TAWS on the MFD

Flight Plan Designator

The flight plan designator mode on the MFD **Map** page is used to select a point on the MAP and transmit coordinates of that point to the FMS for entry as a waypoint.

DESIGNATOR CONTROL

The designator function is entered by selecting the designator prompt on the MFD MAP menu, or by pushing the MFD display select button, when the cursor is on the MFD menu bar and the MAP page is currently displayed on the upper window of the MFD. The designator function exits by the following events.

- Toggling the MFD display select button to move the cursor back to the MFD menu bar.
- Selecting the PFD display select button to move the cursor to the PFD.
- By an automatic cursor synchronization event.

- After 20 seconds of cursor inactivity, the cursor automatically returns to the MFD menu bar.

In designator mode, the inner knob controls the selection of designator reference point. The outer knob continues to control the MFD MAP range. In designator mode, the joystick controls the cursor movement in the MAP window.

DESIGNATOR SYMBOL

When the designator is selected for display, a square green designator symbol is displayed at the present position of the aircraft as the initial reference point.

The designator symbol is displayed at the current cursor location and moves with joystick motion. The curl symbol used to annunciate the function of the inner CCD set knob is displayed adjacent to the designator symbol.

NOTE: The symbol is removed from the CAS scroll window and indicates that the inner knob is controlling the selection of designator reference point.

DESIGNATOR WINDOW

When the designator has been selected for display, a **Designator** window is displayed in the lower portion of the MFD with the **DESIGNATOR** label depicted in gray. The **Designator** window, the waypoint identifier, the designator reference point, bearing and distance from the designator reference point to the designator symbol are displayed in green. When the designator reference point is the present position of the aircraft, **PPOS** is displayed as the identifier.

The identifier for the designator reference point uses a maximum of six characters.

The bearing digital readout uses three digits rounded to the nearest degree and is labeled with a degrees symbol. The bearing readout is padded with the leading edge zeros when the bearing is less than 100 degrees.

The distance readout is rounded to a resolution of 0.1 NM when distance is less than 100 NM and to 1.0 NM when distance is greater than or equal to 100 NM. The distance readout is labeled with a white **NM** abbreviation for nautical mile.

DESIGNATOR FUNCTIONS

When the designator mode is entered, the designator sets to the present position as the initial reference point. The designator mode has four functions, **Next**, **Prev**, **Draw**, and **Select**.

- **Next and Prev Functions** – The Next and Previous functions of the designator mode are used to select a new designator reference point. The selection is done by rotating the inner set knob of the CCD. Clockwise rotation selects **Next**, while counterclockwise rotation selects **Prev**.

  The **Next** selection function of the designator mode moves the designator reference point to the next waypoint and permits sequencing through all waypoints of the active flight plan. The **Next** selection sends the designator reference point to the present position of the aircraft.

  The **Prev** function operates in the converse manner, it moves the designator reference point to the previous waypoint and sequences through the waypoints in reverse. When at the initial reference point (present position of the aircraft), selection of **Prev** moves the designator reference point to the last waypoint.

  The pilot can return the designator reference point to the initial position (present position of the aircraft), by rotating the set knob through a full cycle, or by exiting and re-entering the designator mode using the display select button.

- **Draw Function** – The draw function permits the movement of the designator cursor using the joystick on the CCD. When the designator symbol is moved from its initial position using the draw function, a dashed green line is displayed connecting the designator symbol and the designator reference point. When there is a waypoint downtrack from the reference point a dashed green line is displayed connecting the designator symbol and the next downtrack waypoint.

- **Select Function** – When the designator is offset from the reference point, pushing the **ENTER** button on the CCD transmits the latitude/longitude (LAT/LON) of the designator symbol to the FMS. The FMS shows the latitude/longitude of the designator in the MCDU scratchpad as a requested waypoint. The EDS signals the FMS that the CCD **ENTER** button has been pushed and the FMS can pickup that latitude and longitude from EDS.

A loss of valid heading information, or a loss of valid FMS flight plan information removes the designator symbol and designator window from the display and the designator window menu item on MAP menu is unselectable.

Plan Display

The Plan format, as shown in Figure 6-35, uses a stick map display oriented with North as up. The Plan format can be centered on either the aircraft or the current fly TO waypoint. When the Plan format is shown centered on the aircraft, the map is shown moving beneath the central aircraft symbol. When the Plan format is centered on the fly TO waypoint, the map is stationary and the aircraft is shown moving over the map. The following information can be displayed on the Plan format:

- North-up reference
- Flight plan*
- Navaids*
- Airports*
- Identifiers*
- Distance to waypoint*
- Estimate time en route*
- Navigation source annunciators*
- Desired track*
- Heliports*
- Lateral deviation display*
- Designator display.

NOTE: Information with an ***** indicates that it can be referenced previously in this chapter under Navigation Displays.

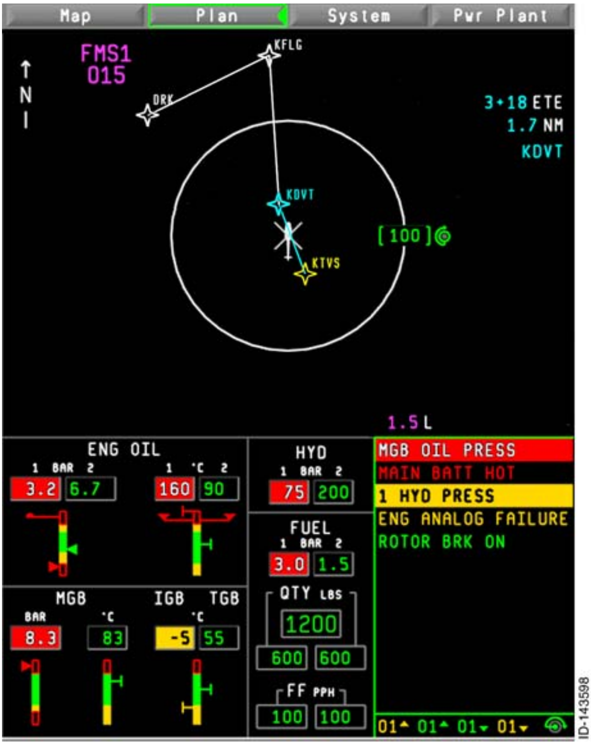


Figure 6-35
MFD Plan Format

The **Plan** button on the menu bar is used to select and control display of the MFD Plan format. When the **Plan** menu button is highlighted, pushing the **ENTER** button on the CCD shows the Plan page. Moving the joystick down when the **Plan** menu button is highlighted shows the **Plan** drop-down menu.

The first three items on the Plan menu, **Navaids**, **Airports**, and **Idents** select parameters are the same as map mode. The **Helicopter Centered** and **Waypoint Centered** select are the focal point of the Plan display. The **Designator** icon shows the designator submenu.

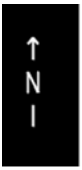
- When the **Helicopter Centered** menu item is selected, the Plan page display is centered on the FMS present position.

- When the **Waypoint Centered** menu item is selected, the Plan page display is centered on the FMS present position.

- When the **Designator** menu item is selected, the Plan display enters the designator mode on the Plan page.

DISPLAY ELEMENTS

- **Heading Display** - The plan mode is always displayed in a true North-up format. The heading source defaults to the on-side AHRS when the display control function is invalid. True North is indicated in the upper left hand corner using an upward pointing arrow labeled in the center with an N shown to the right.



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In this mode, heading data is used to orient the aircraft as it moves around on the active flight plan. FMS magnetic variation is used in conjunction with magnetic heading to orient the aircraft symbol.

A loss of valid heading information from the AHRS removes the aircraft symbol and a red HDG FAIL annunciator is displayed above the half-range ring. The flight plan data remains.

- **PLAN Range Display** – A range ring is used to indicate distance on the display. The ring is labeled with the half-range distance (1/2 of display control range). When either crewmember cursor is on the MFD, the plan range is controlled using the outer set knob of the CCD. Green brackets are placed around the range display to indicate that it is controlled by the CCD. A curl symbol highlighting the outer knob is displayed adjacent to the plan range to indicate which set knob can be used to control the range.

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A loss of valid range information from the display control function shows amber dashes (- - -) in place of the range label.

- **Flight Plan Designator** - The designator mode is available when the Plan page is selected on the MFD and operates in the same manner as when designator is selected on the Map page.

When the designator mode is selected in Plan format and the Plan format is configured to be waypoint centered, the initial position for the designator reference point is the current fly TO waypoint. When the designator mode is selected in Plan format and the Plan format is configured to be waypoint centered, the Plan format is centered on the designator reference point. When the pilot scrolls the designator reference point using the inner knob to select the **Prev** or **Next** waypoint, the Plan format is re-centered to maintain the designator reference waypoint at the center. When the designator mode is exited on the PLAN format and the PLAN format is configured to be waypoint centered, the PLAN format continues to be centered on the last designator reference point.

7. Display Reversion

INTRODUCTION

In the four-display unit (DU) system configuration the manual and automatic DU reversions are supported. The autoreversion functionality reconfigures the display unit to composite format, as shown in Figure 7-1, to display essential data from the PFD and MFD on the non-failed DU.

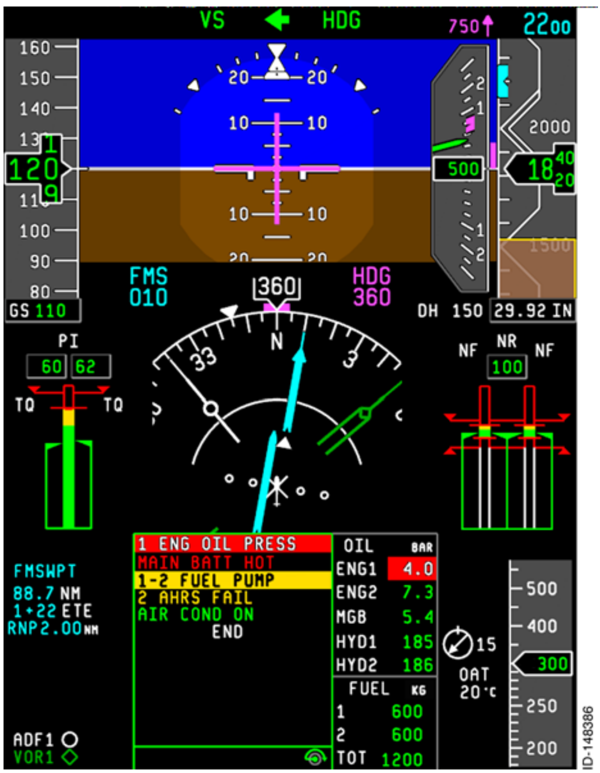


Figure 7-1
PFD/MFD EICAS Reversion Mode

Manual reversion can address potential undetectable failures that can result in a loss of the primary display. The following requirements are applicable for DU autoreversion:

- The pilot (DU3 and DU4) and the copilot (DU1 and DU2) autoreversions are independent of each other.
- Autoreversion enables when the DU reversion switch is in the normal (NORM) position.
- When a DU detects a failure in its paired DU, it reverts to display the composite format.
- When autoreversion occurs, the composite format is shown on the DU. This prevents flashing due to an intermittent failure on the other DU.
- When a pilot toggles the manual reversion switch from NORM to PFD or MFD and back to NORM, the DU restores the normal display format after it senses the paired DU is active.
- Autoreversion is disabled when the left or right engine is started on the ground.
- On initial power-up, when an autoreversion occurs on a DU, it reverts back to display the normal format after it senses the paired DU is active.

MANUAL DISPLAY REVERSION

In the manual display reversion mode, the pilot can combine essential flight data from a failed display unit onto a functioning display and continue the flight. Reversion conditions exist when an MFD or PFD is inoperative.

Under reversion conditions when the MFD is no longer available, the PFD engine monitoring symbols and CAS messages are displayed on the PFD, as shown in Figure 7-1. The PFD shows the minimum data necessary to continue the flight.

NOTE: The same is applicable when the PFD is no longer available.

Reversion Controls

Reversion controls include the DU, air data system and attitude and heading reference system (AHRS). The DU reversion controller, shown in Figure 7-2, can be used to turn OFF a single DU. When a DU is turned OFF with the pilot-side reversion control switch, the system generates a composite display combining primary flight information from the MFD and the PFD. This composite display is presented on the pilot side of the aircraft in the remaining operational DU. This capability exists for both the pilot and copilot in cockpits configured with four DUs.

Figure 7-2
Reversion Control Panel

Assume the MFD in the cockpit has failed and the crew wants to make the copilot-side PFD the composite PFD. The composite display is reconfigured by positioning that reversionary control knob from the NORM (normal) position to the PFD ONLY position. This results in information normally found on the MFD, now displayed in a composite format on the copilot-side PFD, ensuring primary flight information remains available to both pilots.

The reversion control panel can be used to select a specific AHRS and air data system (ADS). The ADS reversion switch is used to select an ADS source for the pilot and copilot displays. The ADS reversion switch has three positions that are listed in Table 7-1.

Table 7-1
ADS Switch Position and Resulting Display

ADS Switch Position	Display
NORM	The on-side ADS is displayed in each PFD. **ADS1** on PFD1 **ADS2** on PFD2
ADS1	Displays **ADS1** on both PFDs.
ADS2	Displays **ADS2** on both PFDs.

The ADS source is the on-side ADS when the display control function becomes unreliable.

The AHRS reversion switch is used to select the AHRS source for the pilot and copilot displays.

The AHRS switch has three positions that are listed in Table 7-2.

Table 7-2
AHRS Switch Positions and Resulting Display

AHRS Switch Position	Display
NORM	The on-side AHRS displayed in each PFD. AHRS1 on PFD1. AHRS2 on PFD2
AHRS 1	AHRS1 displayed on both PFDs.
AHRS 2	AHRS2 displayed on both PFDs.

The AHRS source defaults to the on-side AHRS when the display control function is invalid.

There are two display unit reversion switches, one for each pilot. The display unit reversion switches permit a failed display unit to be turned OFF. When a display unit is turned OFF by way of the reversion switch, the remaining display unit on that side of the aircraft uses a composite format to display essential data from both the PFD and MFD.

Table 7-3 lists the pilot and copilot reversion control switch positions and the resulting DU state.

Table 7-3
3 DU Display Unit Reversion Logic

Copilot Reversion Switch State	Pilot Reversion Switch State	Copilot PFD Display Format	MFD Display Format	Pilot PFD Display Format
Normal	Normal	PFD	MFD	PFD
Normal	PFD	PFD	Off	
Normal	MFD	PFD		Off
PFD	Normal	Reversion	MFD	PFD
PFD	PFD	Reversion	Off	Reversion

Table 7-3 (cont)
3 DU Display Unit Reversion Logic

Copilot Reversion Switch State	Pilot Reversion Switch State	Copilot PFD Display Format	MFD Display Format	Pilot PFD Display Format
PFD	MFD	Reversion	Reversion	Off
MFD	Normal	Off	Reversion	PFD
MFD	PFD	Off	Off	Reversion
MFD	MFD	Off	Reversion	Off

Table 7-4 and 7-5 represent the display unit format resulting from each reversion control switch position during a manual reversion involving the failure of one display unit in an aircraft configured with four displays.

Table 7-4
4 DU Display Unit Reversion Logic - Copilot Switch State

DU 1 Failed	DU 2 Failed	Copilot Reversion Switch State	DU 1	DU 2
		Norm	PFD	MFD
x		Norm	Blank	Reversion
	x	Norm	Reversion	Blank
x	x	Norm	Blank	Blank
		PFD	Reversion	No Power
x		PFD	Blank	No Power
	x	PFD	Reversion	No Power
x	x	PFD	Blank	No Power
		MFD	No Power	Reversion

Table 7-4 (cont)
4 DU Display Unit Reversion Logic - Copilot Switch State

DU 1 Failed	DU 2 Failed	Copilot Reversion Switch State	DU 1	DU 2
x		MFD	No Power	Reversion
	x	MFD	No Power	Blank
x	x	MFD	No Power	Blank

Table 7-5
4 DU Display Unit Reversion Logic - Pilot Switch State

DU 3 Failed	DU 4 Failed	Pilot Reversion Switch State	DU 3	DU 4
		Norm	PFD	MFD
x		Norm	Blank	Reversion
	x	Norm	Reversion	Blank
x	x	Norm	Blank	Blank
		MFD	Reversion	No Power
x		MFD	Blank	No Power
	x	MFD	Reversion	No Power
x	x	MFD	Blank	No Power
		PFD	No Power	Reversion
x		PFD	No Power	Reversion
	x	PFD	No Power	Blank
x	x	PFD	No Power	Blank

During a reversion with the composite display active on the PFD, the following display exceptions exist:

- The CAS window can overlay a portion of the compass rose in the HSI
- During a reversion event, with arc display mode active on the PFD, weather radar is not available.
- The composite mode is given to ensure availability of essential flight information following a failure of one of the aircraft displays. The composite format, as shown in Figure 7-3, is intended to replicate the PFD layout where possible.

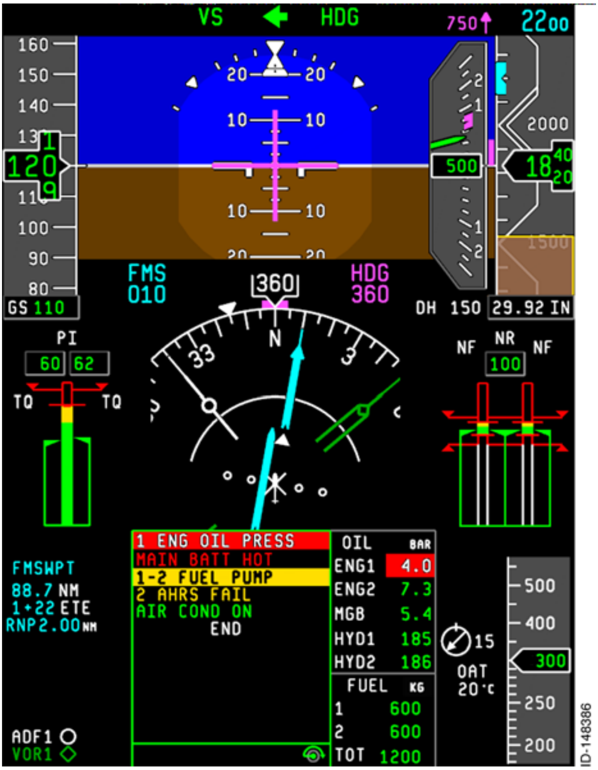


Figure 7-3
PFD/MFD EICAS Reversion Mode

The composite format shows the following data that is normally displayed on the PFD.

- Attitude display

- Barometric altimeter setting
- Slip/skid indicator
- Flight director command bars
- Flight director mode annunciators
- Autopilot mode annunciators
- Vertical deviation pointer and scale
- Radio altitude
- Decision height
- Marker beacons
- Altimeter scale and digital displays
- Airspeed scale and digital displays
- Vertical speed scale and digital display
- Heading
- Drift bug
- Lateral deviation scale
- Bearing 1/2
- Distance
- Ground speed
- FMS messages
- DME identifier
- Preview mode
- ITT, TQ and NG in the form of a power index
- Rotor speed (NF)
- Power turbine speed (NF)
- Source annunciators
- Source miscompare
- OAT display
- Wind display
- TCAS alerts (when installed)
- TAWS alerts (when installed)
- WX/Terrain display
- Hover display.

The PFD, as shown in Figure 7-4, shows the miscompare boxes and their positions in the hover reversion mode.

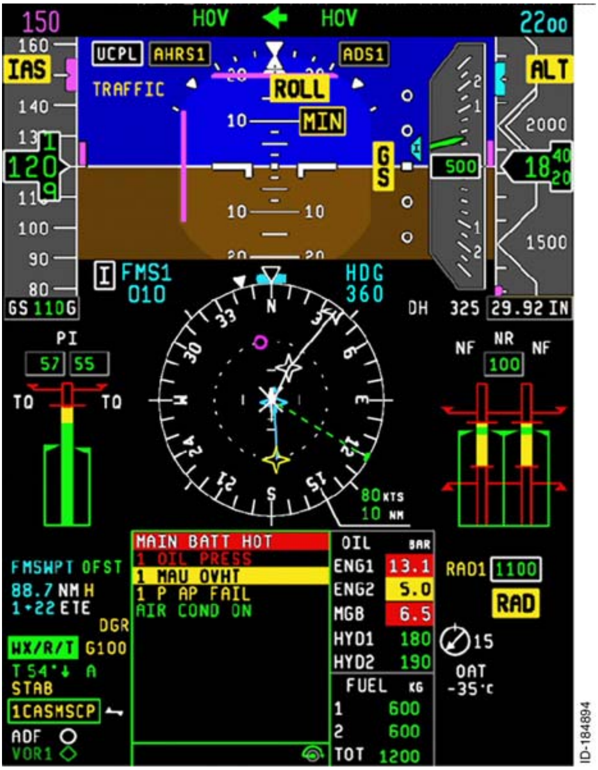


Figure 7-4
PFD Hover Reversion Mode With Miscompare Annunciators

In addition, the following information that is normally presented on the MFD are displayed in the composite format.

- CAS window
- Engine 1 and 2 oil pressures
- MGB oil pressure
- Hydraulic 1 and 2 pressures
- Fuel quantity.

Data that is displayed in reversion mode from the PFD and MFD are the same as described in Sections 5 and 6 with the exception of the following:

- **Attitude Display** - The attitude sphere is truncated to give space for the HSI and the CAS window at the bottom of the display.

- **Horizontal Situation Indicator (HSI)** – The compass rose is slightly overlaid by the CAS window.

- **Display Unit Test Vector Annunciator** – The goal of the 1-2-3-4 DU failure annunciation is a pilot action and the selection of the PFD composite mode is a desired pilot response. Once the PFD composite mode displays the CAS message window with the 1-2-3-4 DU DEGRADE message contained within, there is no need to keep the 1-2-3-4 DU failure annunciator active on the attitude sphere. Therefore, the 1-2-3-4 DU failure annunciator is not displayed on the PFD composite mode due to the presence of the CAS message window.

- **Secondary Engine Indications** – In composite mode, the secondary engine indications on the PFD consist of CAS messages, engine oil pressure, main gearbox oil pressure, hydraulic oil pressure, and fuel quantity.

- **Category A Display** – Category A display is not available in composite format.

8. Automatic Flight Control System (AFCS)

INTRODUCTION

The automatic flight control system (AFCS) gives the following capabilities:

- Preflight test
- Hands-on stability augmentation system (SAS)
- Pitch and roll attitude hold
- Collective control
- Yaw control
- Autotrim
- System and sensors monitoring
- Flight director.

The core elements of the AFCS are two independent autopilot systems, each hosted in a modular avionics unit (MAU).

The AFCS for the AW139/AB139 helicopter is available in three configurations of increasing functionality.

- **Basic Three-Axis System** - This system gives dual pitch, trim, roll, and yaw control. No flight director is included.

- **Three-Axis System with a 2-Cue Flight Director** - In addition to the basic autopilot function described above, this system gives a coupled pitch and roll flight director for navigation and air data sensor operations.

- **Four-Axis System with a 3-Cue Flight Director** - This system is the full standard four-axis implementation with a 3-cue flight director and includes automatic collective control.

The AFCS architecture for the AW139/AB139 helicopter is based on a fail-safe, active-active design. The AFCS uses two independent sets of sensors, two sets of series actuators, two autopilot systems and a single trim system. The AFCS is an active-active system because both autopilots exercise control at the same time. It is a fail-safe system that is easily overridden by the pilot so safe recovery can be made and the helicopter can be flown manually when an autopilot malfunction takes place. The pilot can immediately over-ride the AFCS at any time by manually operating the flight controls. The system gives full control authority to the pilot regardless of whether the autopilot is engaged or disengaged.

NOTE: With the autopilot engaged, a number of options are available so the pilot can manually override the AFCS such as detent switches, force trim release (FTR) switches, autopilot disengage switches, and actuator circuit breakers.

The two independent autopilot systems process data from independent data sources. There are two primary attitude heading reference system (AHRS) sources and a single back-up attitude indicator source. There are two independent air data sources. Each autopilot system generates aircraft control commands that are transmitted to a triaxial set (pitch, roll, yaw) of flight control system series actuators. Two triaxial sets of linear series actuators give inputs to the helicopters main rotor and tail rotor blades. Each triaxial set of actuators electrically interfaces to a single autopilot system. The two-autopilot systems give half the total series actuator system authority.

A single rotary parallel actuator in each control axis supports the autopilot autotrim function. Autotrim commands are generated independently by the autopilot systems. However, the trim actuator units operate on commands issued by the priority autopilot. The source (AP1 or AP2) for the command inputs to the trim actuator is determined by the designated priority AFCS (for trim purposes).

The AFCS function is hosted in the modular avionics unit (MAU). The MAU input/output (I/O) interface for external systems is constructed of three independent components, namely the control I/O, custom I/O, and I/O component of the actuator I/O with processor (AIOP) modules within the MAU. The modules permit data received from the external systems to transmit to the data processing components in each MAU (the processor on the AIOP A module and on the AIOP B module) for the actual aircraft control and monitoring calculations. The processors on the AIOPs, in turn, give control commands to the actuator I/O components on the AIOPs. These commands are transmitted to the linear actuators by way of the control area network (CAN) bus. The CAN bus constitutes the interface between each MAU and the respective triaxial set of series actuators. Additionally, all data transmitted to and from the MAU modules are placed on the avionics standard communications bus (ASCB) by the network interface controller (NIC) so the data can be available to other aircraft systems.

The following flight deck components constitute pilot interfaces for input to the AFCS:

- Autopilot controller
- Guidance controller
- Cyclic, pedal and collective beep switches
- Cyclic, pedal and collective force trim release (FTR) switches
- Display controller
- Remote instrument controller
- Cyclic, pedal and collective trim enable switches
- Remote go-around button
- Cursor control device (CCD) and display units (DU)
- Remote standby
- AP disconnect switch
- Master caution reset.

AFCS COMPONENTS

Depending on configuration, the AFCS can use information from one or two radio altitude sensors for the collective radar height (RHT) hold mode.

The AFCS portion of the PRIMUS EPIC system consists of the following components:

- AFCS processing within each MAU
- Autopilot controller
- Guidance controller
- Smart linear actuators
- Trim actuators
- Air data modules
- Attitude heading reference systems
- Electronic standby instrument system (for third attitude source)
- radio altitude (one or two systems can be installed)
- Cockpit switches and indicators.

Modular Avionics Unit (MAU)

The MAU hosts the hardware required to support the AFCS functions. The MAU gives the input path analog, discrete, and digital data, retains the processors for the AFCS software functions, and gives output paths for discrete and digital signals for control of the aircraft.

Autopilot Controller

The autopilot control panel, shown in Figure 8-1, is located on the center pedestal of the cockpit.

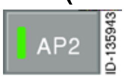
Figure 8-1
Autopilot Controller

The controller gives the means for engaging and disengaging the following systems and functions. Activation of the following are all indicated by the lighting of the green ( ) annunciator light associated with their respective function.

- **AP1 (Autopilot No. 1 Select) Button** – Pushing the **AP1** button

  turns the annunciator light ON and engages the number one autopilot. Pushing the button again turns the annunciator OFF and disengages the number one autopilot.

- **AP2 (Autopilot No. 2 Select) Button** – Pushing the **AP2** button

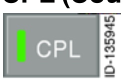


  turns the annunciator light ON and engages the number two autopilot. Pushing the button again turns the annunciator OFF and disengages the number two autopilot.

- **TEST (Built-In Test) Button** – Pushing the **TEST** button lights the

  green ( ) annunciator light and starts the built-in test (BIT).

- **CPL (Couple) Button** – Pushing the **CPL** button manually couples

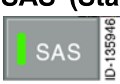


  the flight director (when installed) with the autopilot. Pushing the **CPL** button again uncouples the flight director from the autopilot.

  When the annunciator light is lit, the flight director is coupled. The annunciator light is OFF when the flight director is uncoupled.

  NOTE: The normal operating condition for the autopilot is when the flight director is coupled.

- **SAS (Stability Augmentation System) Button** – Pushing the



  SAS button lights the annunciator and engages the SAS. Pushing the button again turns the annunciator OFF and disengages the SAS.

  NOTE: When the cyclic trim switch is OFF, the autopilot engages with the SAS mode active.

- **ATT (Attitude Mode Select) Button** – Pushing the **ATT** button

  turns the annunciator light ON and engages the attitude (ATT) mode. Pushing the button again turns the annunciator OFF and disengages the ATT mode.

  NOTE: When the cyclic trim switch is ON, the autopilot engages with the ATT mode active. This is the normal operating or default condition.

Guidance Controller

The guidance controller, shown in Figure 8-2, controls most AFCS flight director functions and PFD coupling. The controller is installed in the center column of the cockpit center console.

The mode select buttons on the guidance controller engage and disengage the flight director modes. A green annunciator light on the button and visual annunciators on the PFD indicate that a particular flight director mode is engaged (armed or captured). The buttons are back-lit for visibility in low ambient light conditions.

The **PFD** button selects the PFD (left or right) source information for both flight directors. The PFD source selection is indicated by a green left/right arrow ( ) annunciator located on each side of the PFD button on the guidance controller. When the flight director is valid, the PFD source selection is indicated by a green left/right arrow ( ) annunciator displayed on each PFD.

The pilot controls the direction the arrow points with the **PFD** button in the upper right corner of the guidance controller. When the couple arrow is pointing left, the flight director is engaged to PFD1 and is the primary PFD data source.

When the flight director is invalid, the arrow on the PFD is replaced with an amber FD FAIL annunciator.

Figure 8-2
Guidance Controller for the 4-Axis Configuration

In Figure 8-3, the couple arrow ( ) is centered between the **VS** and **HDG** annunciators at the top of the PFD for ease of view.

Figure 8-3
PFD Couple Arrow

The guidance controller controls the go-around (GA) capability of helicopters equipped with a flight director. The pilot initiates an automated go-around by pushing the **GA** button on the collective control head, shown in Figure 8-5.

The function of each button on the guidance controller is described in the following paragraphs:

- **STBY (Standby) Button** - Pushing the **STBY** button lights the green ( ) annunciator light and cancels any selected active flight director modes. When the autopilot is engaged, it remains engaged in a basic pitch and roll hold.

  Pushing the **STBY** button again, turns OFF the annunciator, cancels STBY, and activates the selected modes.

  Each cyclic pitch control is equipped with a remote **STBY** button. Pushing the **STBY** button on the cyclic control grip initiates the same functions as the STBY switch. The cyclic control grip is shown in Figure 8-4.

- **PFD (Primary Flight Display) Button** - Pushing the **PFD** button selects which PFD (left or right) supplies source data that is used by both flight directors.

  The selected PFD is identified on the control head itself by a green left/right arrow annunciator ( ) located on each side of the PFD button. The lighted arrow indicates the selected PFD.

  The PFD couple arrow annunciator, at the top of the PFD, ( ) lights to confirm which PFD is supplying primary flight director source data.

  When the flight director becomes unreliable, the ( ) PFD couple arrow turns OFF and a **FD FAIL** message is displayed.

- **HDG (Heading) Select Button** - Pushing the **HDG** button lights the green ( ) annunciator and commands the AFCS HDG select mode to steer the aircraft to acquire, capture, and hold the selected magnetic heading displayed on the PFD compass card.

The HDG select mode is engaged by setting the heading bug on the HSI to the desired heading and pushing the **HDG** button. Airspeed must be 60 kts or greater for HDG select mode to engage.

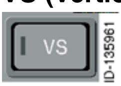
Pushing the **HDG** button again disengages HDG select mode and turns the annunciator OFF.

- **IAS (Indicated Airspeed) Hold Mode Button** – Pushing the **IAS** button lights the green ( ) annunciator and commands the IAS mode to generate pitch commands that maintain a selected aircraft speed.

The IAS mode is engaged by flying the aircraft to the desired airspeed and pushing the **IAS** button. For IAS mode to engage, airspeed must be 60 kts or greater.

Pushing the **IAS** button again disengages the IAS mode and the annunciator turns OFF.

- **VS (Vertical Speed) Mode Button** – Pushing the **VS** button lights the green ( ) annunciator and commands the VS mode to capture and hold a constant vertical speed referenced on the selected PFD. Airspeed must be 60 kts or greater to engage VS mode.



Pushing the **VS** button again disengages the VS mode and the annunciator turns OFF.

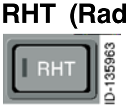
- **ALT (Altitude) Hold Mode Button** – Pushing the **ALT** button lights the green ( ) annunciator and commands the ALT hold mode to capture and maintain a desired altitude.

The ALT mode is engaged by establishing the desired altitude and pushing the **ALT** button. For ALT mode to engage, airspeed must be 60 kts or greater.

When the ALT mode is engaged during a climb or descent, the aircraft levels off at the barometric altitude present at the moment the **ALT** button is pushed.

Pushing the **ALT** button again disengages ALT hold mode and the annunciator turns OFF.

- **RHT (Radar Altitude) Hold Mode Button** – Pushing the **RHT** button lights the green ( ) annunciator and commands the RHT mode to capture and maintain a selected radar altitude.



Minimum absolute altitude for engaging RHT mode is 15 ft AGL.

The RHT mode can be engaged at any absolute altitude between 15 ft and 2000 ft AGL. The RHT mode can remain engaged up to an absolute altitude of 2500 ft AGL. However, when the aircraft descends below 10 ft AGL, the RHT mode disengages automatically.

Pushing the **RHT** button again disengages RHT mode and the annunciator turns OFF.

- **NAV (Navigation) Mode Button** – Pushing the **NAV** button lights the green ( ) annunciator and arms the NAV mode to capture and track the horizontal navigation source displayed on the selected PFD (VOR, LOC, or LNAV). Airspeed must be 60 kts or greater for NAV mode to arm and engage.

ID-135964

  Pushing the **NAV** button again disengages NAV mode and the annunciator turns OFF.

- **APP (Approach) Mode Button** – Pushing the **APP** button lights the green ( ) annunciator and arms the APP mode to capture and track the lateral deviation signal of a tuned and identified VOR, LOC, or both the lateral and vertical navigation signals of an ILS or MLS. Signal capture and tracking is determined by the VOR or LOC that is displayed on the AFCS' coupled PFD.

ID-135965

  Pushing the **APP** button again disengages APP mode and the annunciator turns OFF.

- **DCL (Deceleration) Mode Button** – Pushing the **DCL** button lights the green ( ) annunciator, arms the DCL mode, and engages the IAS mode. With DCL mode armed, at a point after glideslope intercept on a precision approach, the flight director captures the proper pitch attitude and makes the proper power corrections to achieve 70 kts indicated airspeed at or before reaching 200 ft radar altitude in zero wind conditions.

ID-135966

  Pushing the **DCL** button again disengages DCL mode and the annunciator turns OFF.

- **ALTA (Altitude Acquire) Mode Button** – Pushing the **ALTA** button lights the green ( ) annunciator and commands the AFCS to establish a 750 fpm rate of climb or descent as required, and to fly the aircraft to the altitude preset in the altitude select window of the selected PFD.

ID-135967

Pushing the **ALTA** button captures the airspeed existing at the time the mode is engaged and maintains it in the climb or descent.

Upon arrival at the preset altitude, ALTA mode captures the preset altitude. When the preset altitude is successfully captured, the flight director automatically transitions to ALT hold mode.

Pushing the **ALTA** button again disengages ALTA mode and extinguishes the annunciator.

- **HOV (Hover/Velocity) Hold Mode Button** – Pushing the **HOV**

button lights the green ( ) annunciator and commands the AHRS to maintain longitudinal and lateral aircraft velocities for hovering and low speed flight. Pushing the HOV button engages RHT and with pilot discretion, RHT can be disengaged and therefore, engage ALT. The velocity hold is a pilot decision where as RHT or ALT are not required.

  Pushing the **HOV** button again disengages HOV hold mode and the annunciator turns OFF.

- **BC (Back Course) Button** – Pushing the **BC** button lights the

green ( ) annunciator and commands reverse lateral deviation sensing to the CDI. This enables the CDI to capture and track the localizer inbound on the back course with the course pointer set to the front course of the localizer.

  Pushing the **BC** button again disengages BC mode and the annunciator turns OFF.

Linear Actuator

A detailed description of the linear actuator is described in Section 2, System Description.

Rotary Actuator

A detailed description of the rotary actuator is described in Section 2, System Description.

Air Data Module (ADM)

The ADM transmits static and total pressure data to the AFCS. The transmitted air data to the AFCS is as follows.

- Indicated airspeed

- True airspeed
- Barometric altimeter setting
- Pressure altitude
- Vertical speed.

Attitude and Heading Reference System (AHRS)

The following AHRS parameters are transmitted to the AFCS:

- Pitch angle
- Roll angle
- Magnetic heading
- Body pitch rate
- Body roll rate
- Body yaw rate
- Body and earth axis longitudinal acceleration
- Body and earth axis lateral acceleration
- Body and earth axis normal acceleration
- Hybrid along and across heading velocities and accelerations (required for HOV mode).

Electronic Standby Instrument System

The electronic standby instrument system (GH-3100) represents a third source for aircraft pitch and roll attitude and rate data input to the autopilot system. The attitude and rate data from the GH-3100 determines which AHRS has failed when an unflagged miscompare occurs between the two AHRS.

Radio Altitude

The PRIMUS EPIC system on the AW139/AB139 can be (option) interfaced with one or two Honeywell radio altitude sensors that interface to each MAU using an analog interface.

Radar altitude signal and radar altitude valid are the parameters required from the radio altitude. The radio altitude gives an accuracy of three feet or four percent, whichever is greater.

Other Components (Switches, Relays, and Annunciators)

The AFCS requires switches, relays, and annunciators for pilot inputs to the system and for aircraft control. The AW139/AB139 AFCS installation includes the following peripheral components:

- Momentary 4-way collective/yaw beep switch (4-axis AFCS configuration)
- Momentary 2-way yaw beep switch (3-axis AFCS configuration)
- Momentary 4-way cyclic beep switch
- Momentary cyclic force trim release button
- Momentary collective force trim release button
- Momentary yaw force trim release pedal switch
- Two-state cyclic trim enable switch
- Two-state collective/yaw trim enable switch
- Momentary remote GA mode button
- Momentary remote SBY button
- Momentary AP quick disconnect switch

Cyclic Control Head

The AFCS furnishes a cyclic force trim release (FTR) switch located on the cyclic grip, shown in Figure 8-4. When the FTR switch is pushed and held, pitch and roll or cyclic trim are temporarily suspended (such as, for as long as the switch is pushed in).

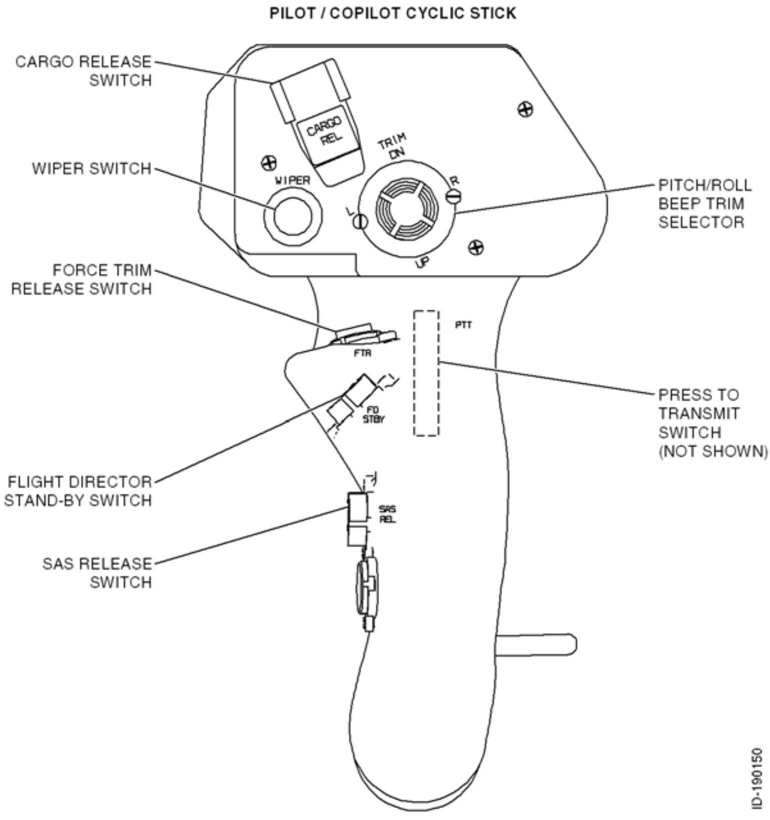


Figure 8-4
Cyclic Control Head

The beep switch is a 4-way switch with respect to a center (neutral) position. Movement of the cyclic beep switch in the forward and aft direction generates a change in the aircraft pitch attitude reference at 2-degree/sec while airspeed is less than 120 knots. A 1-degree/sec rate is used while airspeed is greater than 140 knots. Between 120 and 140 knots the beep rate varies linearly between 2 degrees and 1-degree/sec. Moving the switch in the left-right direction changes the aircraft roll attitude reference at a 3-degrees/sec rate.

FORCE TRIM RELEASE (FTR) SWITCHES

A yaw FTR switch is located on the yaw pedals. This switch temporarily suspends yaw trim. FTR switches immediately disengage the clutches in the trim actuator assemblies and releases the force feel system. There is a single cyclic FTR switch that disengages the cyclic trim actuator clutches, and separate FTR switches that disengage the yaw and collective actuator clutches.

Pushing the cyclic FTR switch suspends pitch and roll trimming and synchronizes the pitch and roll attitude references to present attitude, while permitting rate feedback for damping. Pushing the collective FTR suspends commands to the collective axis. Pushing the yaw FTR switch disables commands to the yaw trim motor, and synchronizes the yaw inner loop heading reference, when active.

Flight Director Collective Control

The collective control, shown in Figure 8-5, is activated by engaging a flight director collective mode with the collective/yaw switch force trim switch (located on the miscellaneous control panel) in the ON position and the flight director is coupled.

NOTE: Figure 8-5 shows the collective stick head where the collective FTR switch and beep trim are installed.

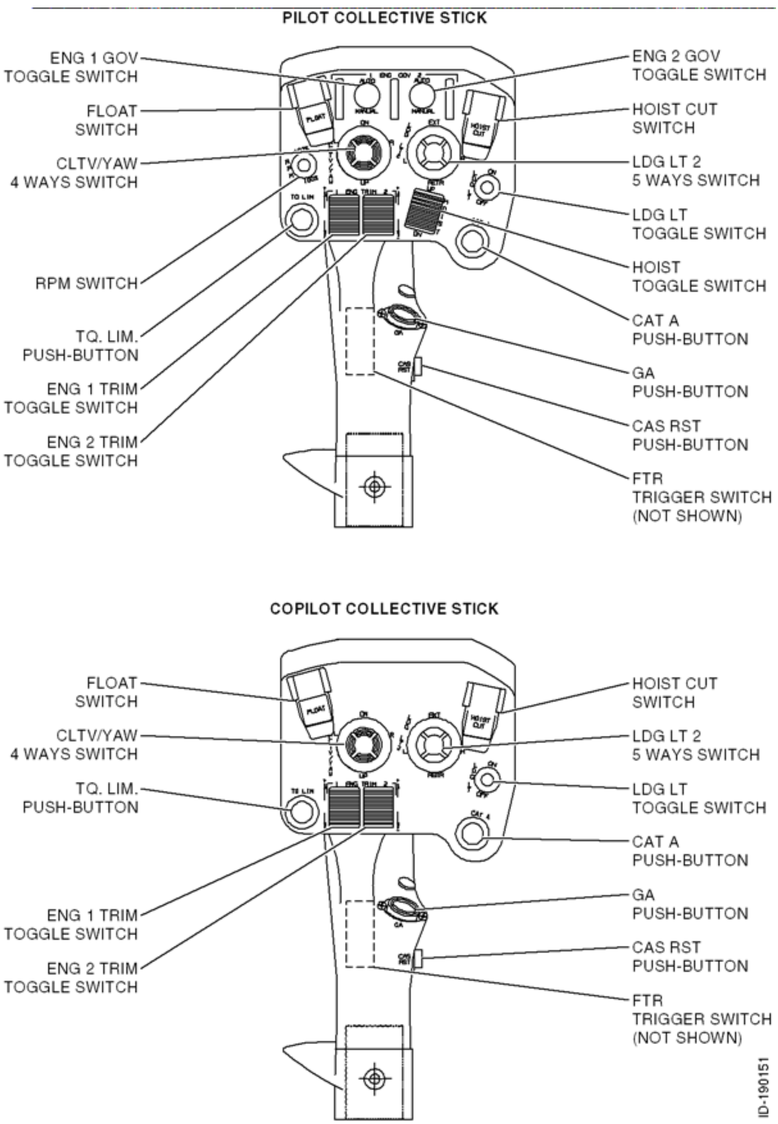


Figure 8-5
Pilot Collective Control Head

Selecting the collective/yaw switch in the OFF position disables the collective actuator clutch and force feel mechanism disables all the flight director collective modes.

The collective FTR switch temporarily disengages collective operation. Force feel is disabled as long as the FTR switch is pushed.

Collective control is disengaged by one of the following:

- Disengaging both autopilots
- Disengaging any active, collective-only mode.

Selecting one of the vertical modes controlled by the flight director establishes a climb, descent or constant altitude condition for the collective control function to maintain. Refer to the specific flight director mode for details on vertical reference change methods and limitations.

When engaged, the collective control function monitors the following parameters to limit collective pitch changes to prevent exceeding engine limitations:

- Interturbine temperature (ITT)
- Compressor speed (NG)
- Power turbine speed (NF).

COLLECTIVE CONTROL FAILURE CONDITIONS AND ANNUNCIATORS

When a collective control failure occurs, the function automatically shuts down and is decoupled from the flight director. The following initiate collective control function failures:

- Invalid collective position sensor
- Failed collective actuator.

A CAS message alerts the pilot when the collective control function is lost.

AFCS FUNCTIONS

Autopilot (AP)

The AFCS incorporates two independent autopilots designated as AP1 and AP2. The individual autopilots process information from numerous independent data sources to generate aircraft control commands for their own triaxial set of linear actuators. The primary data sources are as follows:

- Two AHRS
- Two ADS

- The back up attitude indicator.

In normal operation, each autopilot supplies half the total linear actuator system authority. When one autopilot is engaged, the single system operates at full gain. However, the full gain operation of a single engaged autopilot supplies half the system authority that exists when each AP is operating. When each AP is engaged, each single system gain is reduced to 50% so that each system supplies half of the required input. This results in full gain control with twice the single system authority.

The preflight test verifies that the autopilot control and monitors are working properly. It is engaged when the pilot pushes the **TEST** button on the AP controller. CAS messages and synoptic messages are displayed to show the results of the test to the pilot. Preflight test is inhibited in the air.

Single-pilot IFR operations require an aircraft to exhibit positive longitudinal static stability (aircraft stable around a stick position) and dynamic stability (aircraft stable for a given change in stick position) criteria. When the aircraft fails to meet the minimum stability criteria, artificial stabilization is required. The AFCS enables artificial stabilization in the autopilot.

For single pilot IFR flight, static and dynamic criteria must be met after a single system equipment failure. Therefore, a dual autopilot system is installed to ensure that static and dynamic stability requirements are met after a single system equipment failure.

Engaging and Disengaging the Autopilots

The autopilots engage and disengage by pushing the **AP1** and/or **AP2** buttons on the autopilot controller.

ATT is the default mode when the autopilots are engaged. However, the autopilots are forced to SAS mode when the cyclic trim enable switch is OFF. Engaging the AP activates the automated yaw control function.

NOTE: The pilot has the same control authority over the aircraft whether the autopilot is engaged in SAS or ATT modes and when the autopilot is disengaged.

The autopilots function with or without the flight director guidance modes active. In normal operation, both autopilots are engaged to supply full dual system performance when coupled to the flight director.

With one autopilot is engaged, the single system operates at full gain with half the dual system authority. When both autopilots are engaged, each single system gain is reduced to 50 percent so that each system supplies half of the required input. This results in full gain control with twice the single system authority.

To prevent undesirable transients in the controls at engagement or disengagement, an easy-on/easy-off function drives the pitch, roll and yaw actuators gently back to center. After disengagement and actuator centering, the 28-volt brake excitation is removed, locking the brake actuator in the center position.

AUTOPILOT OVERRIDE

The pilot has full authority with the AP engaged or disengaged and can immediately override the AFCS at any time by simply taking over the controls.

With the autopilots engaged, FTR switches, AP disengage switches, detent switches and actuator circuit breakers offer different ways to partially or completely override the AFCS.

DETENT SWITCHES

Detent switches are located within each axis' force feel assembly to indicate to the AFCS that the pilot has temporarily taken over control of the particular aircraft axis.

Upon detection of the pitch/roll detent switch opening, the AFCS disables commands to the pitch/roll trim motor and limits the pitch/roll linear actuator attitude error response to 50% of the actuator displacement. This permits rate damping of the control movements of the pilot.

Upon detection of the collective detent switch (for four-axis systems) commands to the collective axis are suspended.

Upon detection of the yaw detent switch, the AFCS disables commands to the yaw trim motor and synchronizes the yaw inner loop heading reference, when active.

NOTE: Detent switches can be detected when the force feel system is engaged.

FORCE TRIM RELEASE (FTR) SWITCHES

FTR switches are switches positioned on the cyclic control grip and the collective control grip that the pilot can use to immediately disengage the cyclic and collective force trim and force feel systems. There is a single cyclic FTR switch to disengage the cyclic trim actuator clutches and separate FTR switches to disengage the yaw and collective actuator clutches.

The yaw FTR switches are positioned on the anti-torque pedals and the pilot controls with the balls of his feet. The pilot can use these switches to temporarily suspend yaw trim.

Cyclic FTR

Pushing and holding the cyclic FTR switch suspends pitch and roll trimming so the pilot can manually reposition the cyclic, trimming the aircraft to a new pitch and/or roll attitude unhindered by control feedback.

Releasing the cyclic FTR switch re-engages cyclic trim to maintain the flight controls at the newly trimmed flight attitude and restores force feel.

Collective FTR

Pushing and holding the collective FTR switch suspends collective trimming so the pilot can manually reposition the collective pitch control.

Releasing the collective FTR switch re-engages collective trim. This maintains the newly trimmed collective position and restores force feel.

Yaw FTR

Pushing and holding the yaw FTR switches on the anti-torque pedals suspends yaw trimming so the pilot can manually change the yaw heading reference, when active.

Releasing the yaw FTR switches re-engages yaw trim maintaining the newly established heading and restores force feel.

AUTOPILOT DISENGAGE SWITCHES

The primary means to disengage the autopilot is to push the **AP1** and **AP2** buttons on the autopilot controller. Pushing the AP buttons completely disengages each autopilot and trim system. The linear actuators smoothly return to their centered position and brakes.

The secondary means of disengaging the autopilots is the quick disconnect button mounted on either cyclic grip. Pushing the quick disconnect button simultaneously disconnects both autopilots of the dual autopilot system. The linear actuators are immediately frozen in their current position and trim motor is immediately disengaged, leaving the pilot to manually control the aircraft.

NOTE: Use the quick disconnect button during an event that requires each AP to disengage simultaneously and when the pilot is not able to use the **AP1** and **AP2** buttons to disengage.

ACTUATOR POWER CIRCUIT BREAKERS

There is a circuit breaker for each triaxial set of linear actuators and a single circuit breaker for the trim actuators. Pulling these breakers immediately disables the actuators and completely disables the AFCS from providing inputs to the aircraft control system. This method must be considered as a maintenance means of AFCS disablement.

AUTOPILOT AVAILABILITY

To advise the pilot of a failure of a supporting component, the AFCS gives a CAS message indicating that the availability of the SAS has been degraded. The annunciator serves as an indication to the pilots that they must consider the possible flight envelope limitation.

AUTOPILOT CONTROL AUTHORITY

The autopilot control authority as supplied by the series linear actuators is 10 percent of the full aircraft control authority for each axis. The pilot has the same control authority over the aircraft when the autopilot is engaged in SAS or ATT modes, or when the autopilot is disengaged.

AP FAILURE

When detecting failure affecting mode integrity, the AP of the affected single system disengages. The following events disengages the AP on the corresponding single system:

- Invalid on-side attitude data
- Invalid on-side attitude rate data
- Invalid on-side yaw rate data.

NOTE: A loss of an AP is displayed as a CAS message.

AUTOPILOT MODES OF OPERATION

The AFCS operates in one of two basic modes.

- Attitude (ATT) retention mode
- Stability augmentation system (SAS) mode.

The operation of each mode is described in the following paragraphs:

The ATT mode enables long-term stabilization for hands-off flying and for flight director coupling. The SAS mode gives short-term rate damping and command augmentation for hands-on flying. Activating the SAS mode and activating the ATT mode are mutually exclusive events. Selecting one mode deactivates the other.

NOTE: Yaw control is active when ATT or SAS mode is engaged.

Attitude (ATT) Mode

The uncoupled AFCS attitude function gives hands-off retention of the aircraft pitch and roll attitudes. The system maintains positive static longitudinal stability per IFR requirements. To meet this requirement, the pitch attitude hold reference when airspeed is greater than 40 knots can be modified.

When coupled to a flight director mode, the attitude mode gives hands-off retention of the dynamic attitude reference commands given by the flight director.

When one axis (pitch or roll) is coupled to the flight director, the remaining axis performs the normal uncoupled ATT hold mode of operation.

In high speed cruise flight, ATT mode can be used to maintain roll attitudes or aircraft heading.

Changes to the pitch and roll attitude are made using the cyclic FTR switch or the cyclic beep switch. The cyclic FTR switch is used for large changes in helicopter attitude. The cyclic beep switch is used for small changes in helicopter attitudes.

When engaged, ATT mode is operational throughout the flight envelope.

ATT MODE ENGAGEMENT AND DISENGAGEMENT

Pushing the **ATT** button on the autopilot controller is the primary means of engaging and disengaging ATT mode.

When the cyclic trim switch is in the ON position, the autopilot defaults to the ATT mode when one or both autopilots are engaged.

When the SAS mode is engaged and cyclic trim is ON, the ATT mode is engaged by pushing the **ATT** button on the autopilot control panel.

The ATT mode disengages by any one of the following:

- Engaging the SAS mode
- Setting the cyclic trim switch to OFF
- Disengaging both autopilots.

The CAS message **ATT OFF** is displayed when the SAS mode is engaged.

Activation of the ATT mode is indicated by the lighting of the respective button annunciator.

ATTITUDE MODE REFERENCE

The reference attitude for the mode is initially represented by the attitude of the aircraft at the time the mode is engaged. Changes in the aircraft pitch and roll attitude references can be made by means of the cyclic FTR switch or the cyclic beep switch. Use of the cyclic FTR switch is preferable for relatively large changes in aircraft attitude in the pitch and roll axes. The cyclic beep switch is generally used for relatively small changes in aircraft pitch and roll attitude.

The roll attitude reference is reset to zero when a lateral flight director mode is disengaged by the pilot (excluding HOV mode), or due to a sensor failure. The roll attitude reference is synchronized to the current attitude at the disengagement of HOV mode.

The FTR switch disengages the pitch and roll trim actuator clutch, permitting the cyclic stick to set to a new trim position.

When the FTR switch is pushed and the attitude mode is active, the aircraft attitude pitch and roll references synchronize to the current attitude until the FTR switch is released.

The beep switch is a four-way switch with respect to a center (neutral) position. Movement of the cyclic beep switch in the forward and aft direction generates a change in the aircraft pitch attitude reference at 2-degrees/sec when the airspeed is less than 120 knots. A 1-degree/sec rate is used when the airspeed is greater than 140 knots. Between 120 and 140 knots the beep rate varies linearly between 2 degrees and 1-degree/sec.

Movement of the switch in the left-right direction induces a change in the aircraft roll attitude reference at a 3-degree/sec rate.

HIGH SPEED ROLL ATTITUDE AND HEADING HOLD

Changes to the high speed roll/heading hold reference are performed by temporarily using the cyclic FTR switch or the roll beep switch to reposition the aircraft.

When the yaw control function is active (not in the low speed yaw heading hold subfunction), and the autopilot is not coupled to any flight director modes, the ATT mode holds roll attitudes greater than three degrees. Otherwise, it holds the aircraft heading.

The high speed roll attitude and heading hold modes are submodes of the ATT mode that operate when the autopilot is not coupled to the flight director.

The high speed roll attitude hold function is active at airspeeds above effective translational lift (ETL), or 40 to 45 kts. When active, it holds the aircraft at any established bank angle of 3° or greater. Otherwise, it holds the aircraft heading.

NOTES:

1. Small heading errors are resolved by way of the yaw axis.
2. ATT mode flight limitations are stated in the Agusta Rotorcraft Flight Manual (RFM).

When heading data becomes unreliable, the roll/heading hold function becomes unavailable and the ATT mode reverts to holding the roll attitude.

When airspeed is invalid, the ATT function uses a default airspeed value for gain scheduling of both AFCS channels. The default airspeed is a high speed value so the hold function can be performed.

Stability Augmentation System (SAS)

The SAS mode improves handling characteristics of the helicopter by damping the effect of external aircraft disturbances such as wind, turbulence and poor pilot control technique. The SAS enhances controllability during low speed maneuvering and hovering flight. The SAS mode is intended for use when extensive aircraft maneuvering is required and the pilot prefers to be hands-on without attitude retention. When engaged, the SAS operates throughout the entire flight envelope.

When operating in SAS mode, the cyclic beep switch does not give attitude reference changes. The cyclic beep switch can be used to set certain pitch flight director references. Additionally, in SAS mode the autopilot is not coupled to any flight director references. Since the SAS mode represents a hands-on control mode, the AFCS can be operated with force trim selected either ON or OFF. In the SAS mode, the pitch/roll autotrim function is disabled.

NOTE: The SAS flight limitations are noted in the Agusta Rotorcraft Flight Manual.

SAS ENGAGEMENT AND DISENGAGEMENT

When the cyclic trim switch is in the OFF position, SAS mode is the default autopilot mode when one or both autopilots are engaged.

When the ATT mode is engaged, the SAS mode can be engaged by one of the following actions:

- Pushing the **SAS** button on the autopilot controller
- Turning the cyclic trim OFF.

NOTE: The SAS functions with force trim ON or OFF.

The SAS mode automatically disengages when ATT mode is engaged or when both autopilots are disengaged.

Activation of the SAS mode is indicated by the lighting of the respective button annunciator on the autopilot controller.

The CAS message **ATT OFF** is displayed when the SAS mode is engaged.

When airspeed is invalid, the SAS function uses a default airspeed value for gain scheduling of both AFCS channels.

When the cyclic stick position is invalid, both autopilot systems revert to a degraded SAS mode of operation using attitude rate feedback.

Yaw Control

The yaw control function of the autopilot gives the necessary yaw coordination to maintain proper high speed and low speed directional control. It is operational throughout the flight envelope and operates independently of both the SAS and ATT mode. In addition, it operates independently from the flight director (it is not coupled).

In both high and low speed flight, the aircraft responds to collective pitch changes with lateral movement about the yaw axis. The collective-to-yaw crossfeed function responds to these changes by countering torque effect generated with collective pitch changes.

The autopilot yaw control function consists the following subfunctions:

- Yaw rate damping
- High speed turn coordination
- Low speed heading hold
- Collective-to-yaw cross-feed
- Roll heading hold
- Flight director heading select support
- Lateral ball trim.

YAW CONTROL ENGAGEMENT AND DISENGAGEMENT

The yaw control function engages when either autopilot is engaged and ATT or SAS mode is active. Dual yaw control becomes active when both autopilots are engaged.

Yaw control disengages when both autopilot systems are disengaged.

YAW RATE DAMPING

The yaw rate damping function is active when the yaw control function is engaged. Yaw rate damping improves stability about the yaw axis at all airspeeds and at high speeds it suppresses the Dutch roll tendency of the helicopter.

HIGH SPEED TURN COORDINATION

High speed turn coordination manages movement about the yaw axis during roll controlled heading turns to minimize slips or skids.

The turn coordination feature is given when the yaw control function is active and not in a low speed yaw heading subfunction.

LOW SPEED YAW HEADING HOLD

Low speed heading hold is enabled from an autopilot generated (non-flight director) heading error term.

The function is active when airspeed is less than 41 to 45 knots or when the HOV mode is engaged, the yaw control function is active, the roll axis is not coupled to a roll flight director command (except for HOV mode), and yaw trim is enabled. The transition into low speed yaw heading hold does not occur unless the roll attitude is less that three degrees or HOV mode is engaged.

A low speed heading hold reference is established when the yaw heading hold function becomes active. Changes to low speed heading hold references are performed by the following:

- Repositioning the aircraft nose by applying anti-torque pedal pressure against the force feel system
- Using the yaw FTR (pedal) switch
- Using the yaw beep switch.

NOTE: Additional flight limitations are addressed in the Agusta Rotorcraft Flight Manual.

LATERAL BALL TRIM

The lateral ball trim function is active when the yaw control function is engaged, yaw trim is enabled and airspeed is above ETL. Through this function, the pilot can use the yaw beep switch to position the trim ball to maintain or remove a constant slip or skid or to purposely displace the aircraft tail left or right of the horizontal flight path.

The magnitude of the slip or skid is established by the yaw beep switch.

COLLECTIVE-TO-YAW CROSSFEED

In high and low speed operation, the yaw axis responds to collective position changes to counter the effect of torque when the collective control is moved.

The yaw control function is operational throughout the flight envelope.

YAW ASSIST OF ROLL HEADING HOLD AND FLIGHT DIRECTOR HEADING SELECT

When in roll HDG hold or flight director HDG select mode, the yaw axis drives heading to the heading reference when roll attitude is less than 0.5° and heading error is less than two degrees. Yaw no longer drives heading when the roll attitude exceeds three degrees or heading error exceeds three degrees.

NOTE: Roll attitude is commanded to wings level when yaw is driving heading in the roll HDG hold and flight director HDG select mode.

When airspeed is invalid, the yaw control function uses a high default airspeed value for gain scheduling and for maintaining the yaw turn coordination function.

When the yaw trim is invalid, the yaw heading hold function and the lateral ball trim functions become unavailable.

When on-side heading data is invalid, the yaw heading hold function becomes unavailable and the low speed yaw control function reverts to yaw rate damping.

Collective Control

The collective control function of the AFCS gives automated vertical control of the helicopter. Collective control is operational throughout the flight envelope as long as the collective trim is enabled and a collective flight director mode is selected.

The engine torque (TQ), temperature (ITT) and gas generator speed (NG) parameters are monitored by the autopilot collective control function. This control function prevents engine limitations exceedance. This limiting function is active when the automatic collective control function is engaged.

In helicopters with 4 axis (3 cues) flight director installed, it gives collective position commands for 3-cue operation or for collective-only mode operation (such as radar altitude hold mode).

COLLECTIVE CONTROL ENGAGEMENT AND DISENGAGEMENT

The autopilot collective control function is activated by engaging a collective-only mode when the collective/yaw force trim switch is selected in the ON position and an AP is engaged in ATT mode. When the collective/yaw switch is turned OFF, the collective actuator clutch and force feel mechanisms are disengaged.

NOTE: The collective/yaw switch disables the collective actuator for long durations during flight.

The normal method to temporarily disengage collective operation is by way of the collective FTR switch. The FTR switch gives the pilot the means to temporarily disengage the clutch in the collective actuator and disables force feel.

Collective control can be disengaged by deselecting the collective mode, selecting SAS operation, disengaging both autopilot systems, or uncoupling the flight director from the AP.

NOTE: The AP controlling the collective actuator is the trim master.

The engine TQ, ITT, and NG parameters are monitored by the autopilot collective control function (by way of the displayed PI value on the selected PFD), and used to limit collective inputs to prevent engine/MGB exceedances. This limiting function is active when the automatic collective control function is engaged.

When a collective control failure is detected, the collective control function is inhibited and decoupled from the flight director.

A loss of collective control shows a CAS message. The following events constitute conditions affecting the integrity of the collective control function:

- Invalid collective position sensor
- Failed collective actuator.

NOTE: In addition to collective-to-yaw cross-feed, additional axes cross-feed terms are implemented as required to achieve satisfactory decoupling of the axes.

Automatic Trim (AUTO-TRIM)

The autotrim function maintains roll, pitch, and yaw linear actuators at the center-of-travel position to ensure full actuator authority in response to aircraft control commands. However, in the SAS mode, the pitch/roll autotrim function is disabled.

AUTO-TRIM CONTROL ENGAGEMENT AND DISENGAGEMENT

The pitch and roll autotrim functions are active when the following criteria are met:

- Either one or both autopilot systems are engaged in any mode except SAS
- The cyclic force trim switch is ON.

The yaw autotrim is active when the following criteria are met:

- Either or both autopilot systems are engaged in SAS or ATT
- Collective yaw trim enable switch is ON.

The **trim ON** switches are used to disable trim in flight for long durations. When trim is turned OFF, the trim clutches and force feel mechanisms are disengaged. When cyclic force trim is turned OFF, the SAS mode is activated and the pilot must hand fly the helicopter.

Pushing the cyclic and/or yaw FTR switch temporarily disengages trim. The FTR switches temporarily disengage the clutches in the trim actuator assemblies so the pilot can manually re-trim the aircraft. When pushing the FTR switches, force feel and trim control are disengaged.

NOTE: The yaw FTR switches are attached to the pedals.

Force trim is temporarily disabled by activating the detent switches in the trim actuator assemblies. The detent switches are located in the force feel actuator assembly and inform the AFCS when the pilot temporarily takes control of the aircraft. The AFCS disables respective trim commands when a detent switch is activated.

NOTE: Detent switches can be detected when the force feel system is engaged.

AUTO-TRIM PRIORITY

One trim servo unit is installed for each axis of autopilot control (roll, pitch, yaw). Additionally, a single collective actuator unit is installed.

For normal operation, when one of the two autopilot systems are engaged, the engaged autopilot system retains control of the trim and collective actuator units and is designated as the trim master. When the autopilot is engaged, the first autopilot system engaged remains the trim master.

The first engaged priority scheme permits the pilot to control which side is the trim master.

When autotrim fails, a CAS message indicates which side the failure occurred. The pilot can attempt to restore autotrim by disengaging and re-engaging the autopilot that was controlling the trim at the time of failure. Turning the failed autopilot OFF transfers autopilot priority to the other autopilot channel. This trim master switching logic is overridden when one or more linear actuators fails and the trim master authority automatically switches to the channel with the most functional linear actuators.

AUTO-TRIM CONTROL OPERATION

Activating the autotrim function requires the following criteria:

- Force trim switch in the ON position
- Trim monitor function satisfied
- Autopilot engaged in ATT (either SAS or ATT for yaw trim)
- Aircraft air/ground state is **in air**
- Corresponding FTR switch not pushed
- Corresponding trim actuator detent switch in detent
- Corresponding series actuator is sufficiently displaced from center.

AUTO-TRIM CONTROL FAILURE

When autotrim fails, both autopilots remain in ATT mode and a CAS message alerts the pilot. In this case, the pilot can choose to activate the SAS and hand fly the helicopter or manual trim the helicopter as necessary to keep the trim actuators from saturating.

A display of the linear actuator position is available on the MFD to assist the pilot in manually trimming the aircraft.

AFCS Monitor Description

The AFCS self-monitors the following to detect actuator malfunctions and mitigate the effects of component failures.

AFCS DATA

ASCB data is processed in groups and have associated with them validity variables. These variables are assigned based on data monitoring of key data information.

PITCH LINEAR ACTUATORS MONITOR FUNCTION

The pitch linear actuator monitor inhibits/disengages the pitch axis to prevent the aircraft from exceeding the major malfunction limits due to the following malfunctions:

- Failure of the servo command interface
- Failure of the servo position LVDT feedback
- Failure due to linear actuator faults
- Failure to perform to the minimum servo performance requirements.

ROLL LINEAR ACTUATORS MONITOR FUNCTION

The roll linear actuator monitor inhibits/disengages the roll axis to prevent the aircraft from exceeding the major malfunction limits due to the following malfunctions:

- Failure of the servo command interface
- Failure of the servo position LVDT feedback
- Failure due to linear actuator faults
- Failure to perform to the minimum servo performance requirements.

YAW LINEAR ACTUATORS MONITOR FUNCTION

The yaw linear actuator monitor inhibits/disengages the yaw axis to prevent the aircraft from exceeding the major malfunction limits due to the following malfunctions:

- Failure of the servo command interface
- Failure of the servo position LVDT feedback
- Failure due to linear actuator faults
- Failure to perform to the minimum servo performance requirements.

ATTITUDE AND RATE COMPARISON MONITORS

A monitor scheme uses two AHRS and a standby attitude sensor to detect unflagged failures of all attitude and rate data given by either AHRS.

When the on-side AHRS attitude or rate source has failed, the autopilot disconnects and the **AFCS DEGRADED** and **AP FAIL** CAS messages are annunciated.

When the standby attitude sensor data has failed, neither autopilot disconnects, but the **AFCS DEGRADED** CAS message is annunciated.

NOTE: This monitor is active on the trim master side.

TRIM RUNAWAY MONITORS

The trim runaway monitors detect any condition that results in trim moving in the opposite direction that is indicated by the linear actuator feedback sensor.

Failure resulting from trim moving in a direction opposite to actuator feedback position results in the loss of the autotrim function in that axis and a trim fail CAS message.

NOTE: This monitor is active on the trim master side.

TRIM INOPERATIVE MONITORS

The trim inoperative monitors determine whether the autotrim function is not working. Failure resulting from trim moving in a direction to recenter the linear actuator results in a **1-2 TRIM FAIL** CAS message.

NOTE: This monitor is active on the trim master side.

Preflight Test

The preflight test verifies autopilot control and monitor functionality reducing the possibility of latent failures in critical system components.

As part of the test sequence, the AFCS moves the linear and trim actuators, driving them in opposite directions to limit the movement of the flight controls during the test.

CAS messages and synoptic messages display the results of the test to the pilot.

PREFLIGHT TEST ENGAGEMENT AND DISENGAGEMENT

Upon preflight test engagement, the pilot is directed to push the **SAS** release button. After the preflight test is completed on both AFCS systems, the pilot can exit the mode by pushing the **TEST** button on the AP controller.

Preflight test is used to verify autopilot control and monitor functionality. The underlying tests that are part of this function reduce the possibility of latent failures in these critical system components. As part of the test sequence, the AFCS moves the linear and trim actuators. For the pitch, roll, and yaw axes, the linear and trim actuators are simultaneously driven in opposite directions. This limits the amount of actual flight control movement that occurs during the preflight test. CAS messages and synoptic messages annunciate the status and results of the test.

The preflight test engages (**TEST** annunciator is lit) when the pilot pushes the **TEST** button on the AP controller when the following conditions exist:

- Aircraft is on the ground
- Neither AP is engaged.

Upon preflight test engagement, the pilot is directed to push the **SAS** release button. After the preflight test is completed on both AFCS systems, the pilot can exit the mode by pushing the **TEST** button on the AP controller.

Preflight test halts in the affected channel when any of the following inhibits occur:

- Collective position is initially greater than 10%
- Collective position transitions to a position greater than 15%
- Initial linear actuator state is an engaged state
- Hydraulic pressure on both circuits one and two transitions out of normal operating range
- Linear actuator brake or enable power is removed
- Trim power is removed
- SAS release switch transitions from false to true during actuator tests (fails the AP currently under test).

Preflight test continues, but the associated axis of control fails when any of the following conditions occur:

- Any trim switch transitions from ON to OFF
- Pitch, roll, yaw or collective out of detent switch transitions from false to true
- Cyclic, yaw, or collective FTR transitions from false to true.

The preflight test disengages when any of the following occurs:

- Aircraft transitions to in-air
- Either AP button is pushed
- The **TEST** button on the AP controller is pushed.

AFCS PREFLIGHT TEST RESULTS

When the AFCS preflight test is running, the AFCS MFD synoptic page is displayed for the duration of the test. System failures discovered by the preflight test are displayed in the CAS window.

When the preflight test is running, the AFCS page shows a text box containing any pilot prompts that are necessary. When the AFCS page is manually selected for display when the preflight test is not running, the text box does not display and results of previous tests are not available.

All of the synoptic messages listed in Table 8-1 are present during preflight test upon detection of the message conditions. All messages in the form, **1-2 MESSAGE** can be any of three messages:

- **1 MESSAGE**
- **2 MESSAGE**
- **1-2 MESSAGE**.

Table 8-1
Preflight Text Messages

Message	Conditions
ACT CPLT POWER FAIL	Copilot linear actuators are not powered
ACT PLT POWER FAIL	Pilot linear actuators are not powered
1-2 AUTOTRIM POWER FAIL	Trim actuators are not powered
1-2 HYDRAULIC PRESSURE INVALID	Hydraulic pressure is not in normal operating range
1-2COLLECTIVE TOO HIGH	Collective position is too high
1-2 TRIM OFF	Cyclic trim switch is off
1-2 YAW TRIM OFF	Yaw trim switch is off
1-2 COLLECTIVE OFF	Collective switch is off
1-2 FTR ACTIVE	Cyclic FTR switch is pushed
1-2 YFTR ACTIVE	Yaw FTR switch is pushed
1-2 CFTR ACTIVE	Collective FTR switch is pushed
1-2 PITCH OUT OF DETENT	Pitch trim actuator is held out of detent
1-2 ROLL OUT OF DETENT	Roll trim actuator is held out of detent
1-2 YAW OUT OF DETENT	Yaw trim actuator is held out of detent
1-2 COLLECTIVE OUT OF DETENT	Collective actuator is held out of detent
PRESS AND RELEASE SAS REL SWITCH	Preflight test request for pilot action
1-2 SAS REL SW FAILURE	Preflight test did not detect pilot push of the SAS REL switch
1-2 SAS RELEASE SWITCH ACTIVE	Preflight test detected a push of the SAS REL switch when not expected

When the preflight text box is displayed, a preflight test status for each AFCS is displayed.

All of the status messages listed in Table 8-2 are present during preflight test upon detection of the message conditions. Each status message is preceded by 1 AP or 2 AP to indicate which AFCS the status message applies to.

Table 8-2
Preflight Test AFCS Messages

Message	Condition
AWAITING PRESS	Displayed while waiting for the pilot to push the SAS REL switch
TEST IN PROGRESS	Displayed when on-side AFCS is executing the actuator tests
TEST PASS	Displayed when all tests have been satisfactorily completed
TEST FAIL	Displayed when a test has failed and generated a CAS message
TEST STANDBY	Displayed while waiting for the cross-side AFCS to complete actuator tests
TEST INHIBIT	Displayed when the test is halted due to an inhibit condition
TEST INVALID	On-side AFCS is invalid while cross-side AFCS is running a test

Attitude and Heading Reference System (AHRS) and Air Data Sensor (ADS) Source Selection and Sensor Voting

The autopilot and flight director use AHRS and ADS data. The data can be on-side data, data from the selected PFD, or voted data.

The autopilot uses AHRS and ADS data as follows:

During normal dual system operations, AP1 uses AHRS1 data and AP2 autopilot uses AHRS2 data. When one AP AHRS fails the other AP side mitigates the failure due to the independent AHRS usage. The flagged on-side AHRS failures that disable the autopilot are pitch angle, roll angle, body pitch rate, body roll rate, and body yaw rate.

The AFCS determines the AP that remains engaged when a miscompare is identified between AHRS1 and AHRS2.

Autopilot computations use voted ADS data. Voted data is the average of both primary ADS sensors as long as both sensors are valid. When one of the ADS sensors is determined to be unreliable, the remaining primary ADS sensor data is considered by the system as voted data and is used as such.

When both ADS primary sensors are unreliable, or both are reliable but their outputs disagree, the voted ADS data is set to default airspeeds for both indicated airspeed and true airspeed. This process prevents the autopilot from disengaging.

The flight director uses AHRS and ADS data as follows:

The flight director uses voted AHRS data for various flight director control calculations. Voted data is the average of both primary sensors as long as both sensors are valid.

When one of the AHRS is determined invalid, the remaining AHRS data is considered by the system to be voted data and is used as such. When both AHRS are unreliable, the voted data is unreliable. When both AHRS are reliable but their outputs disagree, the voted data is considered unreliable and the flight director is rendered unreliable.

Flagged AHRS failures that disable the flight director are pitch angle, roll angle, pitch rate, roll rate, yaw rate, lateral acceleration, longitudinal acceleration or normal acceleration.

The flight director uses both selected and voted ADS data with selected ADS data posted on the selected PFD. The selected PFD is determined by the PFD couple arrow controlled by the PFD button on the guidance controller.

Selected ADS data is the primary source for most vertical flight director modes. For example, the PFD couple arrow is pointing right and the IAS mode is engaged, the ADS data displayed on PFD2 is the airspeed data used in the flight director IAS controls.

When the selected ADS is unreliable and the pilot selects IAS, ALT, VS, ALTA or ASEL as a flight director mode, the selected mode is inhibited.

A flight director function is flagged as unreliable when voted ADS data becomes unreliable.

NOTE: The flight director uses selected PFD ADS data. An IAS or VS reference bug cannot exactly match the current airspeed or vertical speed on the nonselected PFD side even when the flight director commands are satisfied.

FLIGHT DIRECTOR

The AFCS dual flight directors give commands for automated control of the helicopter along a desired flight path. The coupled autopilots use the priority flight director commands to drive their actuators thereby exercising control.

Pushing the **CPL** button on the autopilot controller couples the flight director mode to the autopilot. Pushing it again uncouples the flight director mode.

When one AP is engaged in ATT mode, the initial flight director automatically engages.

When in ATT mode and and one flight director mode is engaged, the initial AP automatically engages into ATT mode and the system couples.

When a collective flight director mode is coupled, the CPL light on the autopilot controller is extinguished when the collective force trim switch is OFF.

When an AP is engaged in ATT mode and a flight director mode is engaged, a subsequent AP engagement or additional flight director mode engagements do not change the coupled state.

When uncoupled or in SAS mode, the pilot can manually fly the flight director command bars. In either case, the command bars are displayed on each PFD by the on-side flight director.

Flight director modes remain engaged when a display is reverted to or from composite mode.

Command Bars

Pitch and roll command bars are displayed on the PFD by the AFCS when a flight director mode is active. When there is no flight director mode active the pitch and roll command bars are not displayed.

When HOV mode is the active flight director mode, the pitch and roll command bars are not displayed.

When a flight director mode is active, the flight director controls the directed axis in the command bar.

2-Cue and 3-Cue Operation

2-cue operation refers to a combination of flight director modes that do not include collective control. The flight director is an option and the configuration is a customer request. The guidance controller is the same for the 2-cue and 3-cue flight director.

NOTE: When referring to a 3-axis AFCS, all vertical modes are described as 2-cue.

3-cue operation refers to a combination of flight director modes that include collective control.

NOTE: In a four-axis AFCS, ALT, RHT, ALTA, VS, GS, VGP, and GA are always controlled by the collective axis and are called 3-cue modes.

PI Limiting Function

The PI limiting function is a subfunction of the flight director that is active when a collective flight director mode is engaged. The PI limiting function is always active on the collective axis when IAS mode is engaged and is active on the pitch axis.

The PI limiting function reduces collective pitch up and down commands as necessary to ensure that the power index (PI) does not exceed:

- Takeoff power for AEO when airspeed is below 60 knots
- MCP for AEO when airspeed is above 60 knots
- Maximum continuous power for OEI.

The PI limiting function reduces collective down commands as necessary to ensure the PI remains above 5% on both engines when AEO and above 10% on the remaining engine when OEI. The PI limiting function gives priority to maintaining the collective axis reference and reduces airspeed as necessary to meet the collective axis reference. The pilot-selected IAS reference is not modified, so the airspeed can be regained when the collective axis demand is lowered.

The PI limiting function does not command pitch increases when airspeed is below 80 knots.

The PI limiting function ensures that transmission and engine limitations are not exceeded by reducing collective up and pitch down commands to both the flight director bars and the coupled autopilots.

The PI limiting function priority maintains the collective axis reference, either vertical velocity or vertical position. It reduces airspeed by limiting pitch commands.

The IAS reference selected by the pilot and displayed on the PFD regains when the collective is reduced upon completing maneuvers, such as climbing to a selected altitude.

The PI limiting function is activated by the following combinations of coupled flight director modes:

- IAS and VS
- IAS and ALTA
- IAS and ASEL
- IAS and ALT
- IAS and GS
- DECEL and GS
- GA (4-axis flight director)
- RHT (4-axis flight director).

The PI limiting function limits AEO MCP under steady state conditions to ensure none of the following engine signals exceed the following:

- Left or right engine torque
- Left or right engine ITT
- Left or right engine NG.

A tolerance error exists of -1% on the steady-state limit of 96 - 97% at low altitudes (below 10,000 ft), a steady-state limit of 94 - 95% at high altitudes (above (10,000 ft) and a +5% tolerance on the nonsteady state conditions (mode transitions or turbulence) (102%)

In the event AEO conditions do not exist, such as MCP greater than 100%, the PI limiting function continues to limit AEO MCP. To exceed AEO MCP limitations, the pilot must manually control the collective.

MODES

The AFCS flight director gives a number of lateral and vertical guidance modes. Certain mode options are a function of the navigation source displayed on the PFD and selected with the guidance controller.

The flight director mode selection is accomplished by using switches on the guidance controller or remote mode switches interfaced to the guidance control panel GC-810. The flight director uses the GC-810 button and switch inputs from the number one control IO, when valid, for mode selection.

Table 8-3, AFCS Flight Director Modes, lists the mode capabilities that exist for each version of the AFCS.

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Table 8-3 (Sheet 1 of 5)
AFCS Flight Director Modes

Guidance Controller Button	Function	Control Axis	2-Cue Flight Director	3-Cue Flight Director	SAR Flight Director	Inputs
HDG	Heading Select	Roll and Yaw	Yes	Yes	Yes	Selected PFD heading, Selected PFD heading reference. **NOTE:** The heading referenced is synchronized between PFD1 and PFD2.
ALT	Altitude Hold	Pitch or Collective	Yes	Yes	Yes	Selected PFD Pressure Alt, Baro, Correction Alt Hold reference.
IAS	Indicated Airspeed Hold	Pitch	Yes	Yes	Yes	Selected PFD airspeed, IAS reference.
NAV	Lateral Navigation	Roll	Yes	Yes	Yes	**VOR**: Selected PFD heading, Selected PFD selected course, Selected PFD VOR bearing. **LOC**: Selected PFD heading, Selected PFD selected course, Selected PFD LOC deviation. **LNAV**: Selected PFDs, Selected FMSs roll steering.

Table 8-3 (Sheet 2 of 5)
AFCS Flight Director Modes

Guidance Controller Button	Function	Control Axis	2-Cue Flight Director	3-Cue Flight Director	SAR Flight Director	Inputs
APP	Vertical or Lateral Approach	Roll for VOR or LOC Pitch or Collective for GS Collective for VGP	LOC, GS: Yes VGP: No	Yes	Yes	**VOR**: Selected PFD heading, Selected PFD selected course, Selected PFD VOR bearing. **LOC**: Selected PFD heading, Selected PFD selected course, Selected PFD LOC deviation. **GS**: Selected PFD GS deviation. **VGP (vertical):** Voted vertical speed, Selected PFDs, Selected FMSs vertical speed command. **VGP (lateral):** Selected PFDs, Selected FMSs roll steering.
DCL	ILS Deceleration On VGP Deceleration On	Pitch	No	Yes	Yes	**ILS:** Selected PFD airspeed, 80 knot reference. **VGP:** Selected PFDs, Selected FMSs speed command.
BC	Back-Course Approach	Roll	Yes	Yes	Yes	Selected PFD heading, Selected PFD selected course, Selected PFD BC deviation.

Table 8-3 (Sheet 3 of 5)
AFCS Flight Director Modes

Guidance Controller Button	Function	Control Axis	2-Cue Flight Director	3-Cue Flight Director	SAR Flight Director	Inputs
ALTA	Altitude Acquire	Collective	No	Yes	Yes	Selected PFD baro altitude. ALT reference (preselect). (Note: The ALT ref is synced between PFD1 and PFD2) Voted vertical speed, ALTA vertical speed reference.
VS	Vertical Speed Hold	Pitch or Collective	Yes	Yes	Yes	Voted vertical speed, VS reference.
Remote GA	Go-Around	Pitch for airspeed function Pitch for vertical speed function Collective for vertical speed function Roll for wings level function	Yes	Yes	Yes	**Airspeed Function (four-axis AFCS only)**: Selected PFD airspeed, initial airspeed or 80 knots. **Vertical Speed Function**: Selected PFD vertical speed, 750 FPM reference (three-axis AFCS), 1000 FPM reference (four-axis AFCS). **Roll Axis**: Wings level.
RHT	Radar Altitude Hold	Collective	No	Yes	Yes	Selected PFD radar altitude, RHT reference.
HOV	Hover and/or Velocity Hold	Pitch for longitudinal control Roll for lateral control	No	Yes	Yes	Hybrid along heading and across heading, Selected PFD accelerations, HOV lateral ref, HOV longitudinal reference.

Table 8-3 (Sheet 4 of 5)
AFCS Flight Director Modes

Guidance Controller Button	Function	Control Axis	2-Cue Flight Director	3-Cue Flight Director	SAR Flight Director	Inputs
Remote GA	Transition Up	Pitch for airspeed function Roll for lateral function Collective for vertical speed function	No	No	Yes	Hybrid along heading and across heading, Selected PFD velocities, accelerations, and voted vertical speed. Selected PFD airspeed, Selected PFD radar alt, RHT reference.
TD	Transition Down 1	Pitch for airspeed function Collective for vertical speed function	No	No	Yes	Longitudinal acceleration, voted vertical speed. Selected PFD airspeed, Selected PFD radar alt, RHT reference.
TD	Transition Down 2	Pitch for airspeed function Roll for lateral function Collective for vertical speed function	No	No	Yes	Hybrid along heading and across heading, Selected PFD velocities and accelerations, and voted airspeed. Selected PFD radar alt, RHT reference.
MOT	MOT	Pitch for airspeed function Roll for lateral function Collective for vertical speed function	No	No	Yes	Hybrid along heading and across heading, Selected PFD velocities and accelerations. Selected PFD airspeed, Selected PFD radar alt, RHT reference. Voted vertical speed, Selected PFDs, Selected FMSs vertical speed command, Selected PFDs, Selected FMSs roll steering.
STBY and Remote STBY	Clear all FD Modes		Yes	Yes	Yes	N/A
NOTE: This information is preliminary and is not finalized until additional testing and evaluation is conducted in simulators and the aircraft itself.						

Table 8-3 (Sheet 5 of 5)
AFCS Flight Director Modes

Guidance Controller Button	Function	Control Axis	2-Cue Flight Director	3-Cue Flight Director	SAR Flight Director	Inputs
WTR	Winch operator control HOV	Pitch for longitudinal control Roll for lateral control	No	Yes	Yes	Same as for HOV mode, in addition, the winch operator trim beep inputs.

NOTE: Each flight director mode has the performance section which identifies the target performance for that mode. Those target values include sensor error and apply to the full operational envelope for that mode. This information is preliminary and is not finalized until additional testing and evaluation is conducted in simulators and the aircraft itself.

Heading (HDG) Select Mode

The HDG select mode steers the aircraft to capture, acquire and hold the selected heading reference (magnetic or true depending upon how it is displayed on the PFD compass card). HDG select mode operates on the roll axis and is supported with turn coordination about the yaw axis. The roll flight director command is proportional to heading select error as displayed on the selected PFD.

HDG SELECT ENGAGEMENT AND DISENGAGEMENT

HDG select mode is engaged by setting the heading bug on the HSI to the desired heading and pushing the **HDG** button on the guidance controller. To engage HDG select mode requires airspeed greater than or equal to 60 knots.

HDG select mode engages by the arming the following modes:

- VOR navigation
- VAPP (VOR approach)
- LOC
- BC
- LNAV

HDG select mode is disengaged by:

- Pushing the **HDG** button on the guidance controller
- Selecting **STBY** with guidance controller or remote **SBY** button on either cyclic
- Automatic capture of any other lateral mode
- Airspeed falling below 55 knots
- Toggling the selected PFD.

HEADING SELECT REFERENCE

The heading reference (heading bug) is changed by turning the HDG knob on either remote instrument controller. The HDG knobs are synchronized so the heading reference can be changed by either pilot. The heading reference is displayed on the compass scale of the HSI on the PFD.

Pushing the **Push Sync** button on the remote instrument controller synchronizes the heading reference to the present heading of the helicopter on the selected PFD.

When the heading bug is rotated greater than 180° but less than 360° when **weight-off-wheels**, the flight director captures the new heading in the same turning direction as the rotation of the bug.

The cyclic FTR has no effect on the heading reference. Pushing the cyclic FTR switch when in HDG select results in the autopilot ignoring the HDG command while continuing to give roll rate damping. For example, roll ATT hold with FTR pushed. When the FTR switch is released, the helicopter returns to the heading reference.

In cruise flight, the pilot can manually control the aircraft by moving the cyclic pitch control stick laterally out of detent against the artificial feel loads. Repositioning the cyclic to its trimmed position and releasing it results in the aircraft returning to the heading reference.

The cyclic lateral beep switches have no effect on the heading reference.

HEADING SELECT FAILURES

The loss of the following data disengages HDG select mode:

- Voted air data
- Voted AHRS data
- Software process reliability
- Guidance controller data
- Selected PFD data.

HEADING SELECT PERFORMANCE

The heading select performance is as follows:

- A maximum heading overshoot of two degrees in calm air
- A maximum roll angle limited to a standard rate turn.

When captured on the selected heading, the system holds the selected heading with an accuracy of ±1 degree, with no sustained oscillations within a period less than 20 seconds.

Indicated Airspeed (IAS) Hold Mode

The IAS hold mode generates pitch commands to maintain a selected aircraft speed.

IAS is engaged by flying the aircraft to the desired airspeed and pushing the **IAS** button on the guidance controller. For IAS to engage requires airspeed between 60 and 167 knots.

In a three-axis AFCS, when IAS is engaged any other vertical mode is disengaged.

In a four-axis AFCS, IAS mode engages and controls the pitch axis. When GS, VS, ALT, or ASEL was previously engaged, it remains engaged, but changes the method of control to the collective axis.

In deceleration (DCL) mode, the pilot uses the cyclic longitudinal beep switch or cyclic FTR switch to revert the system to the IAS mode and maintain current airspeed. When the aircraft is in DCL mode and the pilot uses the longitudinal beep switch, the aircraft reverts to IAS mode with an initial IAS reference set to the DCL mode reference value. Arming DCL or engaging ALTA engages the IAS mode.

IAS is disengaged by:

- Pushing the **IAS** button
- Engaging the HOV mode
- Selecting **SBY** on the guidance controller or the remote **SBY** button on either cyclic
- Selecting the GA mode
- Automatic capture of the DCL mode during ILS capture
- Airspeed falling below 55 knots
- Toggling the selected PFD
- For a three-axis aircraft, engaging ALT, GS CAP, ASEL CAP, or VS modes.

IAS MODE REFERENCE

The airspeed reference is displayed as a set bug and as a digital readout on the PFD. The minimum airspeed reference is 60 knots.

The IAS reference is synchronized to the present airspeed at mode engagement. The IAS reference is synchronized to the present airspeed upon a transition from the flight director uncoupled to the flight director coupled.

The pilot can change the airspeed reference using any of the following means:

- Pushing the cyclic FTR switch
- Flying to a new airspeed while keeping the cyclic FTR switch pushed and releasing it
- Positioning the cyclic beep switch forward of neutral to increase the airspeed reference or aft of neutral to decrease the airspeed reference as displayed on the PFD.

The airspeed reference is adjustable by the way of the beep switch between 60 and 167 knots.

The IAS reference changes automatically by the following means:

- The IAS reference is resynchronized when the autopilot is engaged and the IAS mode was engaged with a previously beeped reference.
- The IAS reference remains unchanged when manually controlling the aircraft with the cyclic pitch control stick longitudinally against the artificial feel loads. Releasing the cyclic stick returns the aircraft to the airspeed reference.
- PI limiting is active when IAS mode is engaged during a 3-cue operation and the IAS reference is above the minimum power airspeed (80 knots). When the PI limiting is active and a maximum power condition exists, airspeed automatically reduces. This airspeed reduction is limited to 80 knots to keep the vertical axis reference from becoming unreliable. Once the maximum power is reduced, the airspeed automatically returns to the IAS reference.

NOTE: When the IAS mode is combined with VS, ALTA, VGP, ALT, or GS modes, PI limiting is given during coupled collective operation and can temporarily prevent the AFCS from maintaining the IAS mode reference.

IAS MODE FAILURES

The loss of the following data disengages IAS mode:

- Voted air data
- Voted AHRS data
- Software process validity
- Guidance controller data
- Selected air data.

Once acquired, a steady state IAS mode holds the target airspeed within ±5.0 knots.

Vertical Speed (VS) Hold Mode

The VS mode acquires and holds a constant vertical speed with respect to the VS reference. VS mode controls the pitch axis when the operation is in 2-cue mode.

For a four-axis AFCS operating in 3-cue mode (IAS engaged), vertical speed is controlled on the collective axis when the airspeed is controlled on the pitch axis.

VS MODE ENGAGEMENT AND DISENGAGEMENT

VS mode is engaged by pushing the **VS** button on the guidance controller. Airspeed 60 knots or greater is required for the mode to engage.

Vertical speed between -1000 and +2000 fpm is required for the VS mode to engage.

VS is disengaged by any one of the following:

- Pushing the **VS** button on the guidance controller
- Selecting **STBY** on the guidance controller or the remote **SBY** button on either cyclic
- Selecting any other vertical mode, except GS or VGP arm, DCL arm, or (with a four-axis AFCS) IAS mode
- Automatic glideslope capture
- Airspeed falling below 55 knots
- Toggling the selected PFD
- Controlled by a collective when the engine status is in autorotation or OEI training.

VS REFERENCE

The VS mode reference is displayed as a set bug and as a digital readout on the PFD. Initially, when VS is engaged, the system holds the vertical speed existing at the time of engagement.

For a three-axis AFCS, the pilot can change the VS mode reference by pushing the cyclic FTR switch, flying the helicopter to a new desired vertical speed and releasing the switch.

For a four-axis AFCS that is coupled to the flight director, the pilot can change the VS mode by pushing the collective FTR switch, fly to the desired VS and release the FTR switch.

The VS mode reference for three AFCS operation can be changed by pushing the cyclic beep switch aft to increase the VS mode reference or forward to decrease the VS mode reference.

The VS mode reference for a four-axis AFCS operation can be changed by pushing the collective beep switch aft to increase the VS mode reference or forward to decrease the VS mode reference, as displayed on the PFD.

For a three-axis AFCS, the beep trim permits the VS mode reference to be modified in the range of -1000 feet/min to +2000 feet/min. For a four-axis AFCS, the beep trim permits the VS mode reference to be modified in the range of -1500 feet/min to +2000 feet/min.

The VS mode reference automatically changes within a specified range by the following:

- The VS is resynchronized when there is a transition from flight director uncoupled to flight director coupled.

When the collective pitch is not manually increased in which the aircraft is climbing at the selected VS reference, or a minimum airspeed of 80 knots (VY) is maintained, the internal vertical speed reference is decreased as necessary to prevent the aircraft from decelerating below 80 knots.

NOTE: The displayed vertical speed reference does not change under these circumstances.

For a three-axis AFCS, the pitch axis controls vertical speed with the pilot controlling the collective manually to achieve or maintain the desired airspeed. When the collective position is too low to maintain airspeed, the pitch axis continues to maintain the non-negative climb rate (to prevent loss of altitude), and the airspeed is permitted to decrease until the VS mode disengages.

For a three-axis AFCS, the VS reference remains unchanged when the cyclic pitch control is manually displaced longitudinally against the artificial feel loads. Releasing the cyclic returns aircraft to the VS reference.

For a four-axis AFCS, the VS reference remains unchanged when the collective pitch control stick is manually displaced vertically against the artificial feel loads. Releasing the collective returns the aircraft to the VS reference.

VS MODE FAILURE

The loss of the following data disengages VS mode:

- Voted air data
- Voted AHRS data
- Reliable software processes
- Guidance controller data
- Selected air data.

VS MODE PERFORMANCE

For a three-axis AFCS, the VS mode maintains the vertical speed error within the following conditions:

- ±100 ft/min in calm air steady state conditions
- ±300 ft/min (in calm air) for collective changes.

For a four-axis AFCS, the VS mode maintains the vertical speed error within the following conditions:

- ±100 ft/min in calm air steady state conditions
- ±300 ft/min (in calm air) for collective changes.

Barometric Altitude (ALT) Hold Mode

When ALT is selected, the helicopter is held at the barometric altitude indicated on the selected PFD. The AFCS produces the barometric altitude for use in the ALT mode based on the PFD-selected pressure altitude and the PFD-selected barometric correction as produced by ADS1 when valid. It is controlled with pitch axis commands in three-axis AFCS operation and with collective commands in a four-axis AFCS operation.

ALT MODE ENGAGEMENT AND DISENGAGEMENT

ALT is engaged by establishing the aircraft at the desired altitude and pushing the **ALT** button on the guidance controller. For ALT to engage in a three-axis AFCS, airspeed must be greater than or equal 60 knots.

There is no airspeed constraints of ALT engagement in a four-axis AFCS. For ALT to engage in a four-axis AFCS, weight-on-wheels indicates that the aircraft is in the air.

When ALT is engaged during a climb or descent, the aircraft levels off at the barometric altitude reference present when the **ALT** button is pushed. ALT mode is entered automatically following the capture of the selected altitude in ALTA flight director mode.

In a three-axis AFCS, the engagement of ALT mode disengages any other engaged vertical modes. In a four-axis AFCS, engaging ALT disengages any other vertical mode.

ALT disengages by the following:

- Pushing the **ALT** button on the guidance controller
- Selecting **STBY** with the guidance controller or remote **STBY** button on either cyclic
- Selecting any other vertical mode, with the exception of IAS in a four-axis aircraft
- Automatic capture of the glideslope during ILS mode engagement
- Airspeed falling below 55 knots
- In a four-axis AFCS, transitioning to on-ground
- Toggling the selected PFD
- Pressure altitude miscompare
- For a four-axis AFCS, when the engine status is in autorotation or OEI training.

ALT MODE REFERENCE

The ALT mode reference is displayed as a set bug on the PFD. The ALT reference is synchronized to the present barometric altitude when the mode is engaged on the selected PFD.

For a three-axis AFCS, the ALT reference can be changed by pushing the cyclic FTR switch, flying to a new altitude and releasing it.

For a four-axis AFCS that is coupled to the flight director, the ALT reference can be changed by pushing the collective FTR switch, flying to a new altitude and releasing it.

NOTE: Modifications of the ALT reference by way of the FTR switch occurs when an autopilot is coupled to the flight director.

For a three-axis AFCS, it is possible to modify the ALT mode reference by pushing the cyclic beep switch aft to increase the ALT mode reference or forward to decrease the ALT mode reference as displayed on the PFD.

For a four-axis AFCS, it is possible to modify the ALT mode reference by pushing the collective beep switch aft to increase the ALT mode reference or forward to decrease the ALT mode reference as displayed on the PFD. The beep trim permits the ALT mode reference to be modified in the range of -2,000 to +20,000 feet.

The ALT reference syncs to the current baro altitude within the specified range when there is a transition from flight director uncoupled to flight director coupled.

The changing of the ALT reference results in a reference change aural tone to be played when the reference begins to change. No additional reference change tones are permitted during the period that the reference is changing and five seconds following the completion of the reference change.

Adjusting the barometric setting on the selected PFD induces a corresponding change of the indicated altitude. When changing the barometric setting value with the ALT mode engaged, the mode commands a climb or descent as necessary to return to the barometric altitude corresponding to the altitude indicated at the time ALT mode was engaged, last synced, or beeped.

There is a digital ALT reference displayed on the PFD under certain conditions. The ALT mode digital reference is displayed when ALT is engaged and the selected altitude is invalid. The ALT mode digital reference is displayed when the selected altitude is valid and the ALT reference is changing. The digital ALT reference remains after five seconds after the reference change is completed.

There is an ALT reference bug presented on the altitude tape.

NOTE: When the aircraft has transitioned from ALTA to ALT and is continuing to hold the preselected altitude, the altitude preselect reference has the same numerical value as the ALT reference.

For a three-axis AFCS, the pitch axis controls altitude, and the pilot manually controls airspeed with the collective pitch control stick. The ALT reference remains unchanged when manually controlling the aircraft by moving the cyclic stick longitudinally against the artificial feel loads. After manually controlling the aircraft and releasing the cyclic stick, the aircraft returns to the ALT reference.

When collective pitch is not manually increased, and the selected altitude reference and a minimum airspeed of 80 knots (VY) is maintained, the pitch axis tries to maintain altitude as airspeed decreases until the ALT disengages.

For a four-axis AFCS, the ALT reference is unchanged by manually displacing the collective pitch control stick vertically against the artificial feel loads. After manually controlling the aircraft and releasing the collective stick, the aircraft returns to the ALT reference.

In a three-axis AFCS, the collective longitudinal beep switches have no effect on the ALT reference.

In a four-axis AFCS, the cyclic longitudinal beep switches have no effect on the ALT reference.

ALT MODE FAILURES

The loss of the following data disengages ALT mode:

- Voted air data
- Voted AHRS data
- Software process validity
- Guidance controller data
- Selected air data
- For a four-axis AFCS, power index data.

ALT MODE PERFORMANCE

For a three-axis AFCS in ALT mode, the flight director maintains engaged altitude with no tendency to develop or sustain a cyclic motion about the pitch axis. Under steady-state level conditions, the three-axis AFCS ALT mode holds the reference altitude to the following:

- Within ±25 feet
- ±60 feet with roll/heading changes
- ±100 feet with accelerations/deceleration (collective changes).

NOTE: Sustained oscillations with a period of less than 120 seconds do not occur.

Under steady-state level conditions, with a four-axis AFCS, ALT mode holds the reference altitude to the following:

- Within ±25 feet
- ±60 feet with roll/heading changes
- ±100 feet with accelerations/deceleration (collective changes).

NOTE: Sustained oscillations with a period of less than 120 seconds do not occur.

Altitude Acquire (ALTA) Mode

The ALTA mode commands the helicopter to climb or descend towards the preselected barometric altitude reference while maintaining the existing airspeed. This mode operates through the collective axis.

ALTA ENGAGEMENT AND DISENGAGEMENT

In an aircraft equipped with a four-axis AFCS when the altitude preselect reference is set with the altitude preselect knob, **ALT SEL** knob on the display control panel and the **ALTA** button is pushed on the guidance controller, the ALTA mode engages.

Airspeed of 60 knots or greater is required for the mode to engage. IAS mode simultaneously engages with ALTA mode and the aircraft flies toward the selected altitude.

As the aircraft approaches and captures the preselected altitude, ALTA transitions to ALT mode while IAS mode remains engaged.

NOTE: Changing the altitude preselect reference when ALTA is engaged, results in the mode attempting to capture the new reference once the altitude preselect knob is released (unless the ALTA mode has already transitioned to the ALT mode). Furthermore, changing the altitude preselect reference does not effect the ALTA vertical speed reference.

ALTA armed and captured annunciators are displayed as appropriate.

The ALTA is disengaged by the following actions:

- Pushing the **ALTA** button on the guidance controller
- Selecting **STBY** with the guidance controller or remote **STBY** button on either cyclic
- Selecting any other vertical mode, except GS arm or VGP arm in a 4-axis aircraft
- Automatic capture of altitude for the ALTA->ALT transition
- VGP or glideslope capture
- Airspeed falling below 55 knots
- Toggling the selected PFD
- Loss of altitude preselect reference valid
- Status is autorotation or OEI training.

ALTA REFERENCE

The ALTA mode vertical speed reference is displayed as a set bug and a digital readout on the PFD.

Initially when ALTA mode is engaged, a vertical speed of +1000 feet or -750 feet per minute in the direction of the target altitude is held.

The vertical speed reference for the ALTA mode changes by the pilot using one of the following means:

- Push and hold the collective FTR switch and fly to the desired vertical speed and release the FTR switch.

NOTE: Modification of the ALTA reference by way of the FTR switch occurs when an autopilot is coupled to the flight director.

- Move the collective beep switch aft to increase the vertical speed reference or forward to decrease the vertical speed reference as displayed on the PFD.

The beep trim permits the vertical speed reference to modify between -1500 feet/min to +2000 feet/min.

The minimum vertical speed reference is 100 feet per minute in the direction of the target altitude.

The ALTA mode vertical speed reference syncs to the current vertical speed within the range of minimum to maximum limits when there is a transition from an uncoupled flight director to a coupled flight director.

When the altitude reference changes such that the aircraft vertical direction must be changed, the vertical speed reference reverts to the default vertical speed for that direction.

In cruise flight, the pilot remains able to control the helicopter by moving the collective pitch control stick against the artificial feel loads. Releasing the collective returns the helicopter to the vertical speed reference.

ALTA MODE FAILURE

The loss of the following data disengages ALTA mode:

- Voted air data
- Voted AHRS data
- Software process validity
- Guidance controller data
- Selected air data
- Power index data.

ALTA MODE PERFORMANCE

For ALTA mode, the flight director maintains the vertical speed error within:

- $\pm$100 feet per minute in calm air steady state conditions
- $\pm$300 feet per minute (in calm air) for collective changes

The maximum altitude capture overshoot is less than $\pm$60 feet.

RADIO NAVIGATION MODES

The following five flight director modes are all associated with radio navigation. This section is an overview of those modes.

VOR navigation mode is engaged when VOR1 or VOR2 is the selected NAV on the selected PFD and the **NAV** button on the guidance control panel is pushed. This VOR mode has gains optimized for cruise flight.

VOR approach (VAPP) mode is executed using the same process as VOR navigation mode, except the **APP** button is pushed instead of the **NAV** button. The VAPP mode has gains optimized for an approach.

The localizer mode is engaged when LOC1 or LOC2 is the selected NAV on the selected PFD and the **NAV**, **APP**, or **DCL** button on the guidance control panel is pushed. When the **NAV** button is pushed, a lateral mode (LOC-NAV) is armed or captured. When the **APP** or **DCL** button is pushed, LOC-APP, GS, and (if applicable), DCL modes are armed (and eventually captured).

NOTE: The DCL mode is functional with a four-axis AFCS. Glideslope mode is achieved as described in the previous paragraph. The DCL mode can also be captured at a calculated point after glideslope capture.

Backcourse mode is engaged when LOC1 or LOC2 is the selected NAV on the selected PFD and the **BC** button (when available on the GC-810) is pushed or the course error is greater than 105 degrees from the course pointer when the **APP** button is pushed.

Preview Mode

The preview mode permits the flight director to transition automatically from LNAV mode to VAPP, LOC/GS, LOC/GS-DCL, or BC modes. Normally (non-preview case) after the approach modes are selected, HDG select mode is engaged, while VAPP, LOC, or BC modes are armed until the capture conditions are met. The preview mode permits the pilot to skip the HDG select portion of the approach. The procedure is as follows:

1. An FMS (LNAV) must be selected (by way of the display controller) as the displayed NAV source on the selected PFD.
2. Push the **NAV** button on the guidance control panel to capture LNAV mode (roll steering from the FMS). PFD shows LNAV in the active flight director mode window.
3. Use the **PREV** button on the display controller to select VOR1, LOC1, VOR2, or LOC2 preview mode. Whether VOR or LOC is available is dependent on the radio frequency tuned.

4. Set up the desired previewed VOR, LOC, or BC course selection using the remote instrument controller **COURSE** knob.

5. Push the **APP** or **BC** button (when available), or the **DCL** button on the guidance controller, arming the corresponding approach flight director mode (as dictated by preview NAV source frequency). The PFD shows LOC/GS arm, GS-DCL arm, BC arm, or VAPP arm, as appropriate. The course error determines that a backcourse condition is established based on the preview course and the present heading.

6. When the aircraft flying the FMS steering gets to the appropriate capture point for the VAPP, LOC, or BC mode, the FMS signals that a capture is no longer inhibited and the mode transitions from arm to capture, replacing the flight director LNAV mode. At the same time, the PFD replaces the FMS with the appropriate VOR or LOC as the primary displayed NAV source (the preview display is removed).

VOR Navigation Mode

The VOR navigation mode gives short-range navigation aid to the pilot. The course pointer selects a desired fly to or fly from radial of the VOR station. The VOR navigation mode permits the flight director to give lateral guidance in the roll axis to track the radial selected using the course pointer on the selected PFD.

VOR MODE ENGAGEMENT AND DISENGAGEMENT

To use the VOR navigation mode, tune the navigation receiver to the VOR frequency. The selected PFD must indicate that the VOR is the selected NAV. The course pointer on the compass card is set to the desired course to be flown, and the heading bug is set to fly a heading to intercept the selected VOR radial. After setting all of those preconditions, push the **NAV** button on the guidance controller to arm the VOR navigation mode. Airspeed must be greater than or equal to 60 knots for the VOR navigation mode to arm. When VOR navigation mode arms, the HDG select mode engages. When the aircraft nears the selected course, the flight director automatically disengages the HDG select mode, automatically disengages the VOR navigation armed mode, and automatically engages the VOR navigation capture mode. At VOR navigation capture mode, the aircraft turns on course to follow the selected VOR radial.

The VOR navigation mode disengages by any of the following methods:

- Pushing the **NAV** button on the guidance controller
- Selecting **STBY** through the guidance controller or remote **STBY** button on either cyclic

- Selecting any other lateral mode on the guidance controller
- Selecting another NAV source on the display controller for display on the PFD
- Airspeed falling below 55 knots
- Loss of the tuned VOR signal
- Toggling the selected PFD
- Tuning the NAV radio to a localizer frequency automatically disengages an armed VOR mode
- Tuning the NAV radio to any new frequency (VOR or localizer) automatically disengages a captured VOR mode.

NOTE: The HDG select mode engages when the VOR navigation mode is armed. When the navigation receiver data is not valid prior to transitioning through the VOR capture limit, the lateral beam sensor does not detect the transition within the capture limit, and the system remains in the HDG select mode.

VOR MODE REFERENCE

The VOR navigation mode reference is the selected course displayed on the selected PFD.

The VOR deviation (difference between VOR bearing and selected course) is gain-programmed as a function of distance from the station. The VOR navigation mode determines distance from the station based on a combination of the FMS and DME when available. When neither FMS nor DME is available, default distances are used to gain-program the VOR deviation for the VOR navigation mode.

A course error signal is used for immediate corrections to short-term heading disturbances such as wind gusts. In the presence of a crosswind, a course error offset (crab angle) is determined and used to maintain the aircraft centered on the selected VOR radial.

When overflying a VOR station, a sensor detects the aircraft being within the zone of confusion over the VOR station, and the VOR deviation signal is removed from the command until the VOR signal has stabilized following station passage. When over the station, course changes are possible by selecting a new course using the course selector knob and the aircraft follows the new course.

The cyclic FTR has no effect on the VOR navigation mode reference. Pushing the cyclic FTR switch when in VOR navigation mode results in the autopilot roll channel to ignore the VOR navigation mode command while continuing to give roll rate damping (such as, roll ATT hold with FTR pushed). When the FTR switch is released, the aircraft ramps back to the VOR navigation mode reference.

In cruise flight, it is always possible to manually control the aircraft by moving the cyclic stick laterally against the artificial feel loads. When the cyclic stick is released after its return to the anchored position, the aircraft returns to the VOR navigation mode reference.

Cyclic lateral beep switches do not have any effect on the VOR navigation mode reference.

VOR MODE FAILURE CONDITIONS

Loss of the following data results in the VOR navigation mode to disengage:

- Voted air data
- Voted AHRS data
- Software process validity
- Guidance controller data
- Selected PFD data
- Lateral deviation (not required for VOR arm).

VOR MODE PERFORMANCE

The following assumption is made regarding VOR navigation mode performance:

During capture and over-station maneuvers, the tracking performance assumes that the geometry is not limited by deviation capture limits, bank angle limits, or the ground speed of the aircraft. When any of these parameters become limiting, the tracking error is expanded accordingly.

NOTE: Intercept angles are less than 45°.

The VOR navigation mode performance satisfies the following requirements:

- Lateral deviation overshoot/undershoot - no higher than ±35 μA (2.3°)
- The tracking error - within ±35 μA (2.3°).

When the sensors required to determine distance from the station are invalid, the performance of the VOR navigation mode can be degraded as there is no gain-programming of the control law based on distance to the station.

VOR Approach (VAPP) Mode

The VOR approach (VAPP) mode gives lateral guidance for a nonprecision approach to a VOR navigation facility. Operation of the VAPP mode is similar to the VOR navigation mode. The lateral command gains are optimized to track the selected VOR radial for a VOR instrument approach.

The VAPP mode permits the flight director to give lateral guidance in the roll axis to track the radial selected using the course pointer on the selected PFD.

VOR APPROACH MODE ENGAGEMENT AND DISENGAGEMENT

This mode is armed and captured similar to the VOR navigation mode. To use the VOR approach mode, the navigation receiver is tuned to the VOR frequency. The selected PFD must indicate that the VOR is the selected NAV. The course pointer on the compass card is set to the desired course to be flown, and the heading bug is set to fly a heading to intercept the selected VOR radial. After setting all of those preconditions, pushing the **APP** button on the guidance controller arms the VOR approach mode. Airspeed must be greater than or equal to 60 knots for the VOR approach mode to arm. When VOR approach mode arms, the HDG select mode engages. When the aircraft nears the selected course, the flight director automatically disengages the HDG select mode, automatically disengaging the VOR approach armed mode, and automatically engaging the VOR approach capture mode. At VOR approach capture, the aircraft turns on course to follow the selected VOR radial. The VAPP mode transitions from armed to captured by the way of the preview function.

The following disengages the VAPP mode:

- Pushing the **APP** button on the guidance controller
- Selecting **STBY** through either guidance controller or remote **STBY** button on either cyclic
- Selecting any other lateral mode
- Loss of the VOR signal
- Airspeed falling below 55 knots
- Toggling the selected PFD
- Tuning the NAV radio to a localizer frequency automatically disengages an armed VAPP mode

- Tuning the NAV radio to any new frequency (VOR or localizer) automatically disengages a captured VAPP mode.

NOTE: The HDG select mode engages when the VAPP mode is armed. When the navigation receiver data is not valid prior to transition through VOR capture limit, the lateral beam sensor does not detect the transition within the capture limit, and the system remains in the HDG select mode.

VOR APPROACH MODE REFERENCE

The VAPP reference is the selected VOR course displayed on the PFD.

The VOR deviation (difference between VOR bearing and selected course) is gain-programmed as a function of distance from the station. The VOR approach mode determines distance from the station based on a combination of FMS and DME, when available. When neither FMS nor DME is available, default distances are used to gain-program the VOR deviation for the VOR navigation mode.

NOTE: The FMS distance is not valid unless the FMS is initialized and the GPS is valid.

A course error signal is used for immediate corrections to short-term heading disturbances such as wind gusts. In the presence of a crosswind, a course error offset (crab angle) is determined and used to maintain the aircraft centered on the selected VOR radial.

When overflying a VOR station, a sensor detects the aircraft being within the zone of confusion above the VOR station, and the VOR deviation signal is removed from the command until the VOR signal has stabilized following station passage. While over the station, course changes are made by selecting a new course using the course selector knob and the aircraft follows the new course.

The cyclic FTR has no effect on the VAPP reference. Pushing the cyclic FTR switch when in VAPP mode, results in the autopilot roll channel ignoring the VAPP command while continuing to give roll rate damping (such as, roll ATT hold with FTR pushed). When the FTR switch is released, the aircraft returns to the VAPP reference.

In cruise flight, it is always possible to manually control the aircraft by moving the cyclic stick laterally against the artificial feel loads. When the cyclic is released, and after it returns to the anchored position, the aircraft returns to the VAPP reference.

Cyclic lateral beep switches do not have any effect on the VAPP reference.

VOR APPROACH MODE FAILURE CONDITIONS

The loss of the following data disengages the VAPP mode:

- Voted air data
- Voted AHRS data
- Software process validity
- Guidance controller data
- Selected PFD data
- Lateral deviation (not required for VAPP arm).

VOR APPROACH MODE PERFORMANCE

The VOR approach mode performance criteria is the same as for the VOR mode.

Localizer (LOC) Mode

The LOC mode is used to capture and track the inbound front course of the localizer for approach to a runway by giving lateral guidance in the roll axis. Localizer mode inputs are given from the selected PFD. The LOC mode operates through the roll axis.

LOC MODE ENGAGEMENT AND DISENGAGEMENT

To use the LOC mode, the navigation receiver must be tuned to the localizer (LOC) frequency. The selected PFD must indicate that the localizer is the selected NAV, the course pointer on the compass card is set to the runway inbound course, and the heading bug is set to fly a heading to intercept the selected inbound course. After setting all of these conditions, pushing the **NAV**, **APP**, or **DCL** (DCL in four-axis AFCS) button on the guidance controller arms the LOC mode. Airspeed must be greater than or equal to 60 knots for the LOC mode to arm. When the LOC mode arms, the HDG select mode engages. When **APP** or **DCL** is pushed the GS mode arms. When the aircraft nears the localizer beam, the flight director automatically disengages the HDG select mode, automatically disengages the LOC armed mode, and automatically engages the LOC capture mode. At localizer capture, the aircraft turns inbound to track the localizer to the runway. The LOC mode transitions from armed to captured by way of the preview function. In addition, the LOC mode transitions from LOC inbound tracking to a wings-level roll hold mode when the radio altitude (when valid) is less than 70 feet AGL. Other active modes or submodes that require LOC mode to be engaged will continue as normal.

NOTE: For installations that include a GC-810 without a **BC** button, arming LOC by way of the **APP** button requires that the course error be less than 105 degrees from the course pointer. When GS or LOC are armed, the system automatically transitions from GS/LOC armed to BC armed when the course error is increased to greater than or equal to 105 degrees (when no **BC** button is available). Similarly, when BC is already armed, decreasing course error to less than 105 degrees results in the armed BC to transition to LOC/GS armed. BC cannot be armed by way of the **NAV** or **DCL** button.

The mode is disengaged by the following:

- Pushing the **NAV** button when in LOC-NAV
- Pushing the **APP** button when in LOC-APP
- Loss of GS CAP when in LOC-APP with GS mode captured (note that GS CAP can be lost by engaging a different vertical mode).
- Selecting **STBY** through the guidance controller or remote **STBY** button on either cyclic
- Selecting any other lateral mode
- Selecting a different NAV source on the display controller
- Loss of the tuned localizer signal

- Airspeed falling below 55 knots
- Toggling the selected PFD
- Tuning the NAV radio to a VOR frequency disengages an armed LOC mode
- Tuning the NAV radio to any new frequency (VOR or localizer) disengages a captured LOC mode.

NOTE: The HDG select mode engages when the LOC mode is armed. When the localizer capture criteria are not met, the LOC mode does not transition from armed to captured and the system remains in the HDG select mode.

LOC MODE REFERENCE

The LOC mode reference is the selected course displayed on the selected PFD. The localizer deviation is gain-programmed as a function of distance from the station. The mode determines distance from the station based on a combination of the following:

- FMS
- DME
- Estimated distance based on radar altitude
- Estimated distance based on a default distance at LOC capture and subsequent reduction of distance based on airspeed.

NOTE: In order for the FMS to generate distance information for a tuned localizer, the FMS requires NAVAID identifier information. The pilot can give the tuned NAVAID information to the FMS by entering the desired ILS approach into the flight plan, or by tuning the ILS frequency through entry of the ILS NAVAID identifier on the FMS progress page.

A course error signal is used for immediate corrections to short-term heading disturbances such as wind gusts. In the presence of a crosswind, a course error offset (crab angle) is determined and maintains the aircraft centered on the selected course.

The cyclic FTR has no effect on the LOC mode reference. Pushing the cyclic FTR switch when in LOC mode, results in the autopilot roll channel to ignore the LOC mode command while continuing to give roll rate damping (such as, roll ATT hold with FTR pushed). When the FTR switch is released, the aircraft ramps back to the localizer reference.

In cruise flight, it is always possible to manually control the aircraft by moving the cyclic stick laterally against the artificial feel loads. Upon release of the cyclic stick, after returning to the anchored position, the aircraft returns to the LOC mode reference.

Cyclic lateral beep switches do not have any effect on the LOC mode reference.

Loss of the following data disengages the LOC mode:

- Voted air data
- Voted AHRS data
- Software process validity
- Guidance controller data
- Selected PFD data
- Lateral deviation (not required for LOC arm).

LOC MODE PERFORMANCE

The following assumptions are made regarding LOC performance:

- During capture maneuvers the overshoot/undershoot performance assumes that the localizer intercept is set up such that the geometry is not limited by deviation capture limits, bank angle limits, or the ground speed of the aircraft.

- Intercept angles are less than 45°.

Under the above conditions, the LOC performance is as follows:

- The LOC deviation is within ±75 µA (0.0775 DDM) above 700 ft.

- The LOC tracking error is within ±35 µA (0.03875 DDM), without sustained oscillations, from 700 ft down to 200 ft.

- The LOC deviation is within ±100 µA (0.103 DDM) down to 200 feet under turbulent conditions.

- When the required sensors that determine distance from the station are invalid, the performance of the LOC mode can be degraded as there is no gain-programming of the control law based on distance to the station.

Glideslope (GS) Mode

For a three-axis AFCS, the GS mode gives vertical guidance in the pitch axis to track an ILS glideslope signal. For four-axis AFCS, the GS mode gives vertical guidance in the collective axis to track an ILS glideslope signal.

GLIDESLOPE MODE ENGAGEMENT AND DISENGAGEMENT

When the aircraft LOC mode is armed by pushing the **APP** or **DCL** (DCL in a four-axis AFCS) button on the guidance panel, the GS mode arms simultaneously. After the LOC approach mode has been captured, the armed GS mode can capture. As the aircraft following the localizer signal approaches the glideslope beam, it captures and tracks the glideslope given that the airspeed is greater than or equal to 60 knots. The GS mode can engage using the preview function.

The following disengage the GS mode:

- Pushing the **APP** button on the guidance controller (disengages LOC-APP)
- Pushing the **NAV** button on the guidance controller (LOC-NAV is engaged)
- Selecting **STBY** through either guidance controller or remote **STBY** button on either cyclic
- Selecting any other vertical mode after glideslope capture, except IAS in a four-axis aircraft
- Airspeed falling below 55 knots
- Loss of the glideslope signal
- Toggling the selected PFD
- Loss of LOC captured results in GS captured or GS armed to disengage.
- Loss of LOC armed results in GS armed to disengage
- For a four-axis AFCS, when the engine status is in autorotation or OEI training.

GLIDESLOPE MODE REFERENCE

The GS mode reference is the glideslope signal associated with the localizer navigation facility displayed as the short-range navigation (SRN) source on the selected PFD. The radio pilot-activated self-test (PAST) function is inhibited when the GS mode is tracking the glideslope signal and a valid radio altitude signal indicates the aircraft is below 800 feet AGL or while in auto-level mode.

The glideslope deviation is gain-programmed as a function of radar altitude. When the radio altitude is not available, an estimated altitude based on marker beacons and GS capture is used. The radar altitude test function is inhibited while the glideslope mode is using radar altitude.

When the APP (LOC/GS) mode continues as the aircraft approaches the runway threshold, a flare to a radar altitude of 50 feet is initiated and 50 feet radar altitude is held for a three-axis and four-axis AFCS. When the flare maneuver begins, the GS in the vertical capture modes field of the PFD is replaced by autolevel (ALVL).

For a three-axis AFCS, the cyclic FTR has no effect on the GS mode reference. Pushing the cyclic FTR switch in GS mode results in the autopilot pitch channel ignoring the GS command while continuing to give pitch rate damping (such as, pitch ATT hold with FTR pushed). When the cyclic FTR switch is released the aircraft returns to the GS reference.

For a four-axis AFCS, the collective FTR had no effect on the GS mode reference, regardless of whether or not an autopilot is coupled to the flight director. Pushing the collective FTR switch in GS mode results in the autopilot collective channel ignoring the GS command. When the collective FTR switch is released, the aircraft returns to the GS reference.

For a three-axis AFCS, the pitch axis controls glideslope tracking, and the pilot is required to control the collective manually as necessary to achieve or maintain the desired airspeed. When the pilot does not increase collective sufficiently to permit the glideslope to maintain a minimum airspeed of 80 knots (VY), the pitch axis continues to try to maintain glideslope and the airspeed is permitted to decrease until the GS mode disengages.

For a three-axis AFCS, the GS reference remains unchanged when manually controlling the aircraft by moving the cyclic stick longitudinally against the artificial feel loads. After manually controlling the aircraft by moving the cyclic stick longitudinally against the artificial feel loads, and following the release of the cyclic stick, the aircraft returns to the GS reference as long as the localizer and glideslope signals remain valid.

For a four-axis AFCS, the GS reference remains unchanged when manually controlling the aircraft by moving the collective stick vertically against the artificial feel loads. After manually controlling the aircraft by moving the collective stick vertically against the artificial feel loads, and following the release of the collective stick, the aircraft returns to the GS reference as long as the localizer and glideslope signals remain valid.

For a three-axis AFCS, cyclic longitudinal beep switches do not have any effect on the glideslope reference.

For a four axis AFCS, collective longitudinal beep switches do not have any effect on the glideslope reference.

GLIDESLOPE MODE FAILURE CONDITIONS

Loss of the following data, results in the GS mode disengaging:

- Voted air data
- Voted AHRS data
- Software process validity
- Guidance controller data
- Vertical deviation (not required for glideslope arm).

NOTE: The pilot is alerted during the GS mode when the autolevel submode is inactive due to an invalid radio altitude (such as, the radio altitude fail flag is displayed).

GLIDESLOPE MODE PERFORMANCE

For a three-axis AFCS, GS performance is as follows:

- The GS deviation is within $\pm$75 μA (0.0775 DDM) during airspeed changes, above 700 ft.

- The GS tracking error is within $\pm$75 μA (0.0775 DDM) or $\pm$12 ft whichever is larger, without sustained oscillations, from 700 ft altitude down to 200 ft.

For four-axis AFCS, GS functionality is as follows:

- The GS deviation is within $\pm$37.5 μA (0.0387 DDM) during airspeed changes, above 700 ft.

- The GS tracking error is within $\pm$37.5 μA (0.0387 DDM) or $\pm$6 ft whichever is larger, without sustained oscillations, from 700 ft altitude down to 200 ft.

When the required sensors that determine altitude are invalid, the performance of the GS mode can be degraded as there is no gain-programming of the control law based on altitude.

ILS Deceleration (DCL) Mode

The DCL mode decreases the aircraft from its cruise speed down to approximately 80 knots IAS when the aircraft reaches 200 feet AGL. The control of this mode is from the pitch axis.

ILS DECELERATION (DCL) MODE ENGAGEMENT AND DISENGAGEMENT

Pushing the **DCL** button arms the LOC, GS, and DCL modes, and engage IAS and HDG modes (when conditions for arming are satisfied) in a four-axis AFCS. LOC functions are described in the localizer description, while the GS functions are described in the glideslope function. At the proper point (computed based on airspeed and distance) after GS CAP, the IAS mode disengages and the DCL mode is captured. The airspeed reference bug moves to 80 knots and the digital airspeed reference displayed on the PFD is 80 knots.

NOTE: Regardless of the course error value, and regardless of whether the GC-810 includes a **BC** button, BC mode cannot be armed by way of the **DCL** button.

The following cancel the DCL mode (either arm or capture unless otherwise noted):

- Pushing the **APP** or **NAV** buttons on the guidance controller
- Pushing the **DCL** button on the guidance controller
- Selecting **STBY** through the guidance controller or the remote **STBY** button on either cyclic
- Selecting any other vertical mode after glideslope capture
- Pushing FTR or using longitudinal beep switches drops DCL captured and engages IAS (DCL armed is not affected by the cyclic FTR or cyclic longitudinal beeps)
- Airspeed falling below 55 knots
- Toggling the selected PFD
- Loss of the IAS, NAV or the GS modes.

ILS DCL MODE REFERENCE

The DCL function calculates the approach point at which a deceleration must be initiated to achieve an aircraft speed of approximately 80 KIAS upon reaching 200 feet AGL (near the middle marker) of an approach. That calculation is based on radio altitude and airspeed. When the radio altitude is not available, an estimated altitude based on outer marker and GS capture is used. The DCL mode uses the IAS control law to perform the deceleration function. At the trip point, the IAS reference, which is initially synchronized to current airspeed, is decelerated at a rate of 1.35 feet/second/second down to 80 KIAS. The displayed airspeed reference is 80 knots when DCL is captured. The airspeed reference is displayed as a bug and as a digital readout on the PFD.

The 80 knot DCL reference remains unchanged when manually controlling the aircraft by moving the cyclic stick longitudinally against the artificial feel loads. Under such conditions, following the release of the cyclic stick, the aircraft returns to follow the 80 knot DCL reference.

NOTE: Manual interruption of the automatic DCL mode changes the point of the approach at which 80 knots is achieved and can no longer be at 200 feet AGL, as well as disturb the glideslope tracking.

When the flight director is coupled to an AP, cyclic longitudinal beep switches and the cyclic force trim release switch disengage the DCL CAP mode, and switch the system to IAS mode. For cyclic longitudinal beep switch input, the IAS mode reference is initialized at the 80 knot reference. For cyclic force trim release switch input, the IAS mode reference is synchronized to the current speed.

ILS DCL MODE FAILURE CONDITIONS

The DCL mode disengages when the following data is lost:

- Voted air data
- Voted AHRS data
- Software process validity
- Guidance controller data
- Selected air data.

ILS DCL MODE PERFORMANCE

Upon reaching the target airspeed, DCL mode holds the target airspeed within ±5 knots. The aircraft achieves 80 ±10 knots at or before reaching 200 feet AGL in calm air.

Back Course (BC) Mode

The BC mode captures and tracks the inbound back course of the localizer for approach to a runway by giving lateral guidance in the roll axis. The BC mode operates through the roll axis.

BC MODE ENGAGEMENT AND DISENGAGEMENT

To use the BC mode, the navigation receiver must be tuned to the localizer (LOC) frequency. The selected PFD must indicate that the localizer is the selected NAV. The course pointer on the compass card must be set to the runway inbound course. After these preconditions are set, pushing the **BC** button (when available) on the guidance controller arms the BC mode. The **APP** button is used to arm the BC mode. In addition, the precondition of a course error greater than 105 degrees from the course pointer is used to arm BC mode when the **BC** button is not available.

NOTE: When BC is armed, the system automatically transitions from BC armed to GS/LOC armed when the course error is reduced to less than 105 degrees (assuming an installation of a GC-810 without a **BC** button). Similarly, when GS/LOC is already armed, increasing course error to 105 degrees or greater causes GS/LOC armed to transition to BC armed (if no **BC** button is available).

Airspeed must be greater than or equal to 60 knots for the BC mode to arm. When the BC mode arms, the HDG select mode engages. When the aircraft nears the localizer beam, the flight director disengages the HDG select mode, automatically disengages the BC armed mode, and automatically engages the BC capture mode.

At BC capture, the aircraft turns inbound to track the backcourse of the localizer to the runway. In addition, the BC mode transitions from armed to captured by way of the preview function based on signaling from the FMS.

NOTE: Regardless of the course error value, and regardless of whether the GC-810 includes a BC button, BC mode cannot be armed by way of the NAV or DCL buttons.

The BC mode disengages by the following:

- Pushing the **BC** button (when available) on the guidance controller
- Pushing the **APP** button on the guidance controller when the **BC** button is not available
- Selecting **STBY** through either guidance controller or remote **STBY** button on either cyclic
- Selecting any other lateral mode
- Loss of the localizer frequency
- Airspeed falling below 55 knots

- Toggling the selected PFD
- Tuning the NAV radio to a VOR frequency automatically disengages an armed BC mode
- Tuning the NAV radio to any new frequency (VOR or localizer) automatically disengages a capture BC mode.

NOTE: The HDG select mode engages when the BC mode is armed. When the localizer capture criteria are not met, the BC mode does not transition from armed to captured, and the system remains in the HDG select mode.

BC MODE REFERENCE

The BC mode reference is the selected course as displayed on the selected PFD. Localizer signal capture and tracking are based on the course and deviation displayed on the selected PFD.

The BC deviation is gain-programmed as a function of distance from the station. The mode determines distance from the station based on a combination of:

- FMS
- DME
- Radio altitude
- Estimated distance based on BC capture.

NOTE: In order for the FMS to generate distance information for a tuned localizer, the FMS requires NAVAID identifier information. The pilot can give the tuned NAVAID information to the FMS by entering the desired ILS approach into the flight plan, or by tuning the ILS frequency through entry of the ILS NAVAID identifier on the FMS progress page.

A course error signal is used for immediate corrections to short-term heading disturbances such as wind gusts. In the presence of a crosswind, a course error offset (crab angle) is determined and used to maintain the aircraft centered on the selected course. BC operates the same as the LOC mode, with the deviation and course signals reversed to make a back course approach on the localizer.

The cyclic FTR has no effect on the BC mode reference. Pushing the cyclic FTR switch while in BC mode results in the autopilot roll channel ignoring the BC command while continuing to give roll rate damping (such as, roll ATT hold with FTR pushed). When the FTR switch is released, the aircraft ramps back to the BC mode reference.

In cruise flight, it is always possible to manually control the aircraft by moving the cyclic stick laterally against the artificial feel loads. When the cyclic stick is released, after it returns to the anchored position, the aircraft returns to BC mode reference. Cyclic lateral beep switches have no effect on the BC mode reference.

BC MODE FAILURE CONDITIONS

The loss of the following data results in the BC mode disengaging:

- Voted air data
- Voted AHRS data
- Software process validity
- Guidance controller data
- Selected PFD data
- Lateral deviation (not required for BC arm).

BC MODE PERFORMANCE

The following assumptions are made regarding BC performance:

- During capture maneuvers, the overshoot/undershoot performance assumes that the localizer intercept is set up such that the geometry is not limited by deviation capture limits, bank angle limits, or the ground speed of the aircraft
- Intercept angles are less than 45°
- Applies when flying inbound to the runway at or above 400 feet AGL.

Under the above conditions, the BC performance is as follows:

- The BC tracking error is within ±75 μA (0.0775 DDM), without sustained oscillations
- Maximum undershoot/overshoot is 100 μA (0.103 DDM).

When the sensors required to determine distance from the station are invalid, the performance of the BC mode can be degraded as there is no gain-programming of the control law based on distance to the station.

Long-Range Navigation (LNAV) Mode

The AFCS LNAV function follows roll steering commands given by the FMS by setting the roll attitude reference as commanded by the FMS. The LNAV function can be used for en route lateral navigation guidance, as well as for lateral guidance in the execution of nonprecision approaches. The LNAV mode operates through the roll axis.

LNAV MODE ENGAGEMENT AND DISENGAGEMENT

To use the LNAV-NAV mode, the selected PFD must indicate that the FMS is the selected NAV. After setting the preconditions, pushing the **NAV** button on the guidance controller arms the LNAV-NAV mode. Airspeed must be greater than or equal to 60 knots for the LNAV-NAV mode to arm. When LNAV-NAV mode arms, the HDG select mode engages. When within the capture zone, the FMS and AFCS automatically disengages the HDG select and LNAV-NAV armed modes, and automatically engages the LNAV-NAV captured mode. The LNAV-NAV mode guides the aircraft to capture and track the active FMS flight plan leg.

NOTE: Generally, the LNAV-NAV armed phase (with HDG select mode) is a short duration. Most FMS flight plans start from the present position, such that the capture criteria are immediately met. In addition, the LNAV-APP mode can be armed by way of the **APP** or **DCL** buttons.

The LNAV mode is disengaged by the following:

- Pushing the **NAV** button on the guidance controller when in LNAV-NAV mode
- Pushing the **APP** button on the guidance controller when in LNAV-APP mode
- Selecting **STBY** through either guidance controller or remote **STBY** button on either cyclic
- Selecting any other lateral mode
- Selecting a different NAV source on the display controller
- Airspeed falling below 55 knots
- Toggling the selected PFD
- Auto transition to a radio NAV mode.

LNAV MODE REFERENCE

The LNAV mode controls the aircraft by the way of the lateral steering commands received from the FMS. The LNAV reference is the FMS desired track displayed on the HSI.

The cyclic FTR has no effect on the LNAV reference. Pushing the cyclic FTR switch in LNAV mode results in the autopilot roll channel ignoring the LNAV command while continuing to give roll rate damping (such as, roll ATT hold with FTR pushed). When the FTR switch is released, the aircraft ramps back to the LNAV reference.

In cruise flight, it is always possible to manually control the aircraft by moving the cyclic stick laterally against the artificial feel loads. When the cyclic is released, after its return to the anchored position, the aircraft returns to the LNAV mode reference.

Cyclic lateral beep switches do not have any effect on the LNAV mode reference.

LNAV MODE FAILURE CONDITIONS

The loss of the following data results in the LNAV mode disengaging:

- Voted air data
- Voted AHRS data
- Software process validity
- Guidance controller data
- FMS data.

LNAV MODE PERFORMANCE

The system tracks the FMS commands to within $\pm 2.0°$ of roll under calm air conditions.

Vertical Glide Path (VGP) Mode

In a four-axis AFCS, the flight director VGP mode follows vertical speed commands given by the FMS for the purpose of tracking the FMS-created vertical path down to the FMS missed approach point. The VGP mode operates through the collective axis.

VGP MODE ENGAGEMENT AND DISENGAGEMENT

To use the VGP mode, the selected PFD must indicate that the FMS is the selected NAV. After setting the precondition and when the FMS indicates that VGP is arm-capable, pushing the **APP** button on the guidance controller arms the LNAV-APP and VGP modes and engages HDG mode.

When **DCL** is pushed instead of **APP**, then LNAV-APP, VGP, and VGP DCL modes are all armed, when HDG and IAS modes are engaged.

NOTE: When VGP mode is armed or captured, the **LNAV** button annunciator is not lit even though LNAV mode is active. The pilot needs to modify the heading reference so that the aircraft intercepts the FMS desired track. When LNAV capture criteria are met, HDG disengages and LNAV-APP transitions from armed to captured. After the LNAV-APP mode has captured, the armed VGP mode can be captured.

As the aircraft following the LNAV track approaches the FMS vertical path, it captures and tracks the vertical path when the airspeed is greater than or equal to 60 knots.

The following disengages the VGP mode (armed or captured, unless otherwise noted).

- Pushing the **APP** button on the guidance controller (disengages VGP and LNAV)
- Pushing the **NAV** button on the guidance controller (disengages VGP and LNAV remains engaged)
- Selecting **STBY** through the guidance controller or remote **STBY** button on either cyclic
- Airspeed falling below 55 knots
- Toggling the selected PFD

- The engine status is autorotation or OEI training
- Selecting a different NAV source on the display controller
- Selecting a preview NAV source (VOR or LOC) for display disengages VGP arm
- Loss of FMS valid
- LNAV (arm or capture) disengagement
- Loss of the VGP arm flag from the FMS disengages VGP arm
- Loss of VGP capture signal from the FMS disengages VGP capture
- Loss of FMS vertical speed target valid disengages VGP capture
- Selecting an other vertical mode except IAS disengages VGP capture.

VGP MODE REFERENCE

The VGP mode controls the aircraft by way of vertical speed commands received from the FMS. The VGP mode reference is the vertical track, given by the FMS displayed as the NAV source on the selected PFD.

When the VGP mode has continued and the aircraft approaches the runway threshold, an asymptotic flare to a radar altitude of 50 feet is initiated and 50 feet radar altitude is held.

When the flare maneuver has begun, the VGP in the vertical (collective) capture mode field of the PFD is replaced by autolevel (ALVL).

NOTE: The ALVL submode does not occur when the missed approach point (MAP) is greater than 150 feet AGL. The VGP mode disengages at the MAP (preceded by a VTA annunciator above the vertical guidance scale), and an AFCS mode change chime rings.

The collective FTR has no effect on the VGP mode reference, regardless of whether or not an autopilot is coupled to the flight director.

Pushing the collective FTR switch in VGP mode, results in the autopilot collective channel ignoring the VGP command. When the collective FTR switch is released, the aircraft returns to the VGP reference.

The VGP reference remains unchanged when manually controlling the aircraft by moving the collective stick vertically against the artificial feel loads. When in VGP mode, manually controlling the aircraft by moving the collective stick vertically against the artificial feel loads, and following the release of the collective stick, the aircraft returns to the VGP reference.

For a four-axis AFCS, collective longitudinal beep switches do not have any effect on the glidepath reference.

VGP MODE FAILURE CONDITIONS

The loss of the following data results in the VGP mode disengaging:

- Voted air data
- Voted AHRS data
- Software process validity
- Guidance controller data
- FMS data
- Power index data.

The pilot is alerted when the following conditions exist during VGP mode:

- Autolevel submode is inactive due to an invalid RADALT (a radar altimeter fail flag is displayed)

VGP MODE PERFORMANCE

The system tracks the FMS vertical speed commands to within $\pm$100 feet per minute under calm air conditions.

VGP Deceleration (DCL) Mode

The VGP DCL mode generates pitch commands to decelerate the aircraft during a VGP approach.

VGP (DCL) MODE ENGAGEMENT AND DISENGAGEMENT

Pushing the **DCL** button when an FMS is the selected NAV arms the LNAV-APP, VGP and VGP DCL modes, and engages the IAS and HDG modes (when the conditions for arming are satisfied).

Using the MCDU, the pilot selects an initial speed and distance. After capturing LNAV-APP and reaching the initial speed and distance, the VGP DCL mode transitions from armed to captured (as long as current airspeed is greater than the initial speed).

Using the MCDU, the pilot selects a final speed and the distance from the destination at which the final speed target should be achieved (final distance). The FMS calculates the point in the approach at which the deceleration to that final speed begins (assuming 1.35 feet/per second/per second deceleration). At the calculated point the FMS transitions the speed target from the initial speed to the final speed.

The following cancels the DCL mode (either armed or captured, unless otherwise specified).

- Pushing the **APP** or **NAV** buttons on the guidance controller
- Pushing the **DCL** button on the guidance controller
- Selecting **STBY** through the guidance controller or remote **STBY** button on either cyclic
- Airspeed falling below 55 knots
- Toggling the selected PFD
- Selecting an other vertical mode after VGP is captured
- Selecting ALTA or IAS modes (effects DCL CAP)
- Pushing FTR switch when coupled, or using longitudinal cyclic beep switches when coupled drops DCL CAP and engages IAS (DCL ARM is not affected by cyclic FTR or cyclic longitudinal beeps)
- Loss of the IAS, LNAV or VGP modes.

VGP DCL MODE REFERENCE

The VGP DCL mode references are the FMS initial speed and the FMS final speed. These FMS speed targets are mutually exclusive (both cannot be active simultaneously). The active FMS speed target is shown on the PFD as an airspeed reference bug and digital airspeed reference when VGP DCL is captured.

The DCL reference remains unchanged when manually controlling the aircraft by moving the cyclic stick longitudinally against the artificial feel loads. Under these conditions, following the release of the cyclic stick, the aircraft returns to follow the DCL reference.

NOTE: Manual interruption of the automatic DCL mode changes the point of the approach at which the final speed target is achieved, as well as disturb the VGP tracking.

When the flight director is coupled to an AP, cyclic longitudinal beep switches, and the cyclic force trim release switch disengages the DCL CAP mode and switches the system to IAS mode.

For cyclic longitudinal beep switch input, the IAS mode reference is initialized to the FMS final speed reference. For cyclic force trim release switch input, the IAS mode reference is synchronized to the current speed.

VGP DCL MODE FAILURE CONDITIONS

The loss of the following data results in the DCL mode disengaging:

- Voted air speed
- Voted AHRS data
- Software process validity
- Guidance controller data
- Selected air data.

VGP DCL MODE PERFORMANCE

Upon reaching the target airspeed, DCL mode holds the target airspeed within $\pm$5.0 knots.

Go-Around (GA) Mode

The GA mode gives aircraft control for an automatic ascent profile. The function is intended primarily for use during the approach phase of flight to initiate a missed approach. When the GA mode is engaged, it commands a 750 feet/minute climb (three-axis AFCS) or a 1000 feet/minute climb (four-axis AFCS), a wings level attitude, and a 70 knot airspeed. The GA mode in a three-axis AFCS operates through the pitch and roll axes. The GA mode in a four-axis AFCS operates through the pitch, roll, and collective axes.

GO-AROUND MODE ENGAGEMENT AND DISENGAGEMENT

The GA mode is engaged by pushing the remote go-around switch (on either collective grip) when airspeed is greater than or equal to 60 knots. Any roll mode is selected after engagement of the GA mode.

When the GA mode is engaged in a three-axis AFCS, the following occurs:

1. All other flight director modes are canceled
2. Roll attitude is commanded to wings level (no annunciator is displayed in the captured lateral flight director mode field of the PFD and no roll flight director bar is displayed).
3. The pitch attitude controls the climb rate, and the pilot must manually control the collective to maintain the desired airspeed.

NOTE: Aircraft with a three-axis AFCS shows an additional power index cue during GA mode to remind the pilot to adjust collective appropriately to support the 750 fpm climb. Aircraft with a four-axis AFCS does not include this display element.

When the GA mode is engaged with a four-axis AFCS, the following occurs:

1. All other flight director modes are canceled.
2. Roll attitude is commanded to wings level (no annunciator is displayed in the captured lateral flight director mode field of the PFD and no roll flight director bar is displayed).
3. The collective controls the climb rate, and simultaneously pitch attitude controls airspeed.

The GA mode disengages by the following:

- Selecting **STBY** on the guidance controller or remote **STBY** button on either cyclic
- Selecting any other vertical mode
- Automatic capture of altitude during altitude preselect
- Toggling the selected PFD
- Airspeed falling below 55 knots
- For a four-axis AFCS, when the engine status is in autorotation or OEI training.

Once GA mode is engaged, the pilot can select an autopilot roll mode as the active lateral mode. Selecting a roll mode cancels the wings-level roll submode of the GA mode.

GO-AROUND REFERENCE

For a three-axis AFCS, the GA mode vertical speed reference is displayed as a 750 feet/minute set bug and a digital readout on the PFD. The pitch axis controls vertical speed and the pilot is required to control the collective manually as necessary to achieve or maintain the desired airspeed. If the pilot fails to increase collective sufficiently, the pitch axis continues to try to achieve the climb rate, and the airspeed decreases until the GA mode disengages.

With a four-axis AFCS in GA mode, the collective axis controls vertical speed and the pitch axis is commanded to control airspeed. The GA mode vertical speed reference is displayed as 1000 feet/minute set bug and a digital readout on the PFD. The GA mode airspeed reference is set to current airspeed or the minimum power airspeed (80 knots), whichever is higher. When the airspeed reference is above 80 knots and a maximum power condition exists, the airspeed reference is automatically reduced (down to a minimum of 80 knots) as necessary to satisfy the vertical speed reference. For a four axis AFCS, the GA mode airspeed reference is displayed as a bug and digital readout on the PFD.

The cyclic longitudinal/lateral beep switch and the collective longitudinal beep switch does not have effect on any GA reference.

In a three-axis AFCS, the cyclic FTR has no effect on the GA mode vertical speed reference, regardless of whether or not an autopilot is coupled to the flight director. Pushing the cyclic FTR switch when the GA mode is active permits the pilot to manually control the attitude about the pitch and roll axes by moving the cyclic stick. With the FTR switch activated, the autopilot gives rate damping in the pitch and roll axis. Upon release of the FTR switch and centering the cyclic stick, the aircraft is commanded to the original GA mode vertical speed reference.

For a four-axis AFCS, the collective FTR has no effect on the GA mode vertical speed reference, regardless of whether or not an autopilot is coupled to the flight director. Pushing the collective FTR switch when the GA mode is active permits the manual control of the collective by way of the collective stick. Upon release of the collective FTR switch and the collective switch, the aircraft returns to the original GA mode vertical speed reference.

For a four-axis AFCS, the cyclic FTR has no effect on the GA mode airspeed reference, regardless of whether or not an autopilot is coupled to the flight director. Pushing the cyclic FTR switch when the GA mode is active permits the pilot to manually control the aircraft attitude about the pitch and roll axes by moving the cyclic stick. With the FTR switch activated, the AP provides rate damping in the pitch and roll axis. Upon release of the FTR switch and centering of the cyclic stick, the aircraft returns to the original GA mode airspeed reference.

For a three-axis AFCS, the GA vertical speed reference remains unchanged when manually controlling the aircraft by moving the cyclic stick longitudinally against the artificial feel loads. After manually controlling the aircraft and following the release of the cyclic stick, the aircraft returns to the GA vertical speed reference.

For a four-axis AFCS, the GA vertical speed reference remains unchanged when manually controlling the aircraft by moving the collective stick vertically against the artificial feel loads. After manually controlling the aircraft and following the release of the collective stick, the aircraft returns to the GA vertical speed reference.

For a four-axis AFCS, the GA airspeed reference remains unchanged when manually controlling the aircraft by moving the cyclic stick longitudinally against the artificial feel loads. After manually controlling the aircraft and following the release of the cyclic stick, the aircraft returns to the GA airspeed reference.

GO-AROUND MODE FAILURE CONDITIONS

The loss of the following data results in the GA mode disengaging:

- Voted air data
- Voted AHRS data
- Software process validity
- Guidance controller data
- Selected air data
- For a four-axis AFCS, power index data.

GO-AROUND MODE PERFORMANCE

For a three-axis AFCS in GA mode, when the system is stabilized on the power setting for go-around and the aircraft is reconfigured, the aircraft maintains $\pm$100 fpm of the commanded go-around climb rate.

For a four-axis AFCS in GA mode, when the system is stabilized on the power setting for go-around and the aircraft is reconfigured, the aircraft maintains $\pm$100 fpm of the commanded go-around climb rate. Once acquired, a steady state GA mode hold the target airspeed within $\pm$5.0 knots.

Hover/Velocity Hold (HOV) Mode

The HOV mode utilizes the longitudinal and lateral acceleration information from the AHRS to give commands that maintain longitudinal and lateral aircraft velocities for hovering and low speed flying. The HOV mode operates through the pitch and roll axes.

When the selected on-side ground velocities are invalid, the cross-side ground velocities are used. This automatic data source selection is intended to give uninterrupted HOV mode control when the selected AHRS ground velocities are lost.

HOV MODE ENGAGEMENT AND DISENGAGEMENT

The HOV mode is engaged by pushing the HOV button on the guidance controller, or by pushing the cyclic beep switch in the center position (5th position). The conditions necessary to engage the HOV mode are:

- Airspeed less than 75 knots
- HOV mode is enabled by way of the options parameter
- Radio altitude greater than 15 feet
- Forward ground velocity less than 60 knots
- Aft ground velocity less than 40 knots
- Lateral (left or right) ground velocity less than 40 knots
- Combined aft and lateral ground velocities (such as velocity vector) less than 40 knots.

NOTE: Engaging the HOV mode (by way of the HOV button or cyclic beep center position) engages the RHT mode. However, RHT disengagement does not force HOV disengagement.

HOV mode engagement results in all other flight director modes (other than RHT, TD2 and MOT) to disengage.

The HOV mode is canceled by the following:

- Pushing the **HOV** button on the guidance controller
- Selecting **STBY** through either guidance controller or remote **STBY** button on either cyclic
- Selecting any other pitch or roll mode
- Toggling the selected PFD
- Airspeed rising above 80 knots
- Forward ground velocity rising above 65 knots

- Aft ground velocity rising above 45 knots
- Lateral (left or right) ground velocity rising above 45 knots
- Combined aft and lateral ground velocities (such as velocity vector) rising above 45 knots
- Radio altitude (when valid) falling below 10 feet.

HOV MODE REFERENCE

An analog display of the velocity references are displayed on the PFD hover display. The HOV mode velocity references are set to zero upon HOV engagement.

The HOV mode velocity references are changed by the pilot using any of the following means:

- Pushing the cyclic FTR switch, flying to the desired lateral and longitudinal velocities, and releasing the cyclic FTR switch

NOTE: Modification of the HOV mode velocity references by way of the FTR switch occurs regardless of whether or not an autopilot is coupled to the flight director.

- Pushing the cyclic beep switch forward, aft, right, or left with respect to its neutral position to increase the velocity reference in the direction of the switch push
- Pushing the cyclic beep switch in the center position.

The HOV mode velocity references are limited to 60 knots forward and 40 knots left, right, and aft. When an aft HOV mode velocity reference is present, the velocity vector formed by the longitudinal and lateral references are limited to a maximum of 40 knots.

The HOV mode syncs to current velocities within the specified limits when there is a transition from flight director uncoupled to flight director coupled.

It is always possible to manually control the aircraft by moving the cyclic stick against the artificial feel loads. Upon releasing the cyclic stick, the aircraft returns to the HOV velocity references.

NOTE: Torque limiting does not affect HOV functionality.

HOV MODE FAILURE CONDITIONS

The HOV mode disengages if any of the following data is lost:

- Voted air data

- Voted AHRS data
- Display selected AHRS ground velocities
- Software process validity
- Guidance controller data.

HOV MODE PERFORMANCE

Once acquired, a steady state HOV mode holds the target velocities within ±1 knot, however, this does not include sensor error.

Radar Altitude Hold (RHT) Mode

The RHT mode gives four-axis equipped aircraft the control commands to acquire and maintain a selected radio altitude (radalt) height. The mode is intended for aircraft hover and low airspeed maneuvering, or for cruise flight above a flat surface. The RHT mode is controlled by the collective axis. When the selected on-side radar altitude is invalid, the cross-side radar altitude (when available) is used. This automatic data source selection is intended to provide uninterrupted RHT mode control in the event that the selected RADALT data is lost. RHT mode can be operational in conditions up to and including sea state three. The radar altitude PAST test function is inhibited when the RHT mode is engaged.

RHT MODE ENGAGEMENT AND DISENGAGEMENT

The RHT mode is engaged by pushing the **RHT** button on the guidance controller. Radar altitude must be valid and between 15 and 2000 feet for the RHT mode to engage. The RHT mode engages when HOV mode is engaged by the way of the **HOV** button or pushing the cyclic (5th position) beep switch.

The RHT mode is canceled by any one of the following:

- Pushing the **RHT** button on the guidance controller
- Selecting **STBY** through either guidance controller or remote **STBY** button on either cyclic
- Selecting any other vertical mode, except IAS, GS arm, VGP arm, or DCL arm
- Automatic capture of glideslope
- Automatic capture of VGP
- Loss of radio altitude valid signal for five seconds
- Toggling the selected PFD
- Radar altitude falling below 10 feet

- Autorotation, or OEI training engine condition
- Radar altitude rising above 2050 feet
- Radar altitude miscompare
- radio altitude test is active.

RHT REFERENCE

The radio altitude at engagement is the RHT reference. When the RHT mode is engaged, the RHT reference is displayed as a reference bug on the radio altitude tape and as a digital display at the top of the tape. The RHT reference is displayed on the PFD when the RHT mode is engaged.

The pilot can modify the RHT (when coupled) reference by pushing the collective FTR switch, flying to the desired vertical speed, and releasing the FTR switch. The pilot can modify the RHT reference by pushing the collective beep switch forward to decrease the RHT reference or aft to increase the RHT reference.

The RHT reference syncs to current radar altitude within the specified limits when there is a transition from flight director uncoupled to flight director coupled.

The changing of the RHT reference results in a reference change aural tone to be played when the reference begins to change. No additional reference change tones are permitted during the period that the reference is changing and five seconds following the completion of the reference change.

The RHT reference is limited from 15 to 2000 feet AGL. The RHT reference has a 1-foot resolution for values below 250 ft, and a 10-foot resolution for values above 250 ft. The radar altitude test function is inhibited when RHT mode is using radar altitude.

When the RHT mode is active, the aircraft can be manually controlled by moving the collective stick vertically against the artificial feel loads. When the collective is released, the aircraft returns to the RHT mode reference.

RHT MODE FAILURE CONDITIONS

The loss of the following data results in the RHT mode disengaging:

- Voted air data
- Voted AHRS data
- Software process validity

- Guidance controller data
- Radar altitude
- Power index data.

RHT MODE PERFORMANCE

Under steady-state level conditions, RHT mode holds the reference radar altitude to $\pm$10 feet or $\pm$60 feet with roll/heading changes, not including sensor error. No sustained oscillations with a period less than two minutes will occur.

Stand-By (STBY) Mode

Selecting the STBY mode resets (disengages and de-arms) all flight director modes. This mode is selected by the **STBY** button on the guidance controller or a remote button located on the cyclic.

Beep Switches

The two beep switches at each pilot stations are used to modify various AP and flight director references. In general, the beep switches modify flight director references when flight director modes are engaged and AP references when flight director modes are not engaged. When the pilot selects to not couple the flight director modes (by pushing the **CPL** button), the cyclic beep switches modify AP references.

There can be special instances where the beep switch input initiates a transition to a different mode (such as DCL CAP mode transition to IAS mode upon beep input).

FORE/AFT CYCLIC BEEPS

When IAS mode is engaged, it is possible to beep the IAS reference as long as:

- ATT mode is engaged and coupled.

When VS three-axis AFCS mode is engaged, it is possible to beep the VS reference as long as:

- ATT mode is engaged and coupled.

When HOV mode is engaged, it is possible to adjust aircraft longitudinal velocity.

When ATT mode is engaged and not coupled, it is possible to beep pitch attitude reference.

When coupled, it is possible to beep pitch attitude reference as long as no pitch flight director mode is engaged.

LEFT/RIGHT CYCLIC BEEPS

When HOV mode is engaged and coupled, it is possible to beep the HOV lateral reference.

When HDG mode is engaged and coupled, it is possible to beep the selected heading.

When ATT modes are engaged and not coupled, it is possible to beep roll attitude reference.

When coupled, it is possible to beep roll attitude reference as long as no roll flight director mode is engaged.

FORE/AFT COLLECTIVE BEEPS

When RHT mode is engaged, it is possible to beep the RHT reference.

When VS four-axis AFCS mode is engaged, it is possible to beep the VS reference.

When ALTA four-axis AFCS mode is engaged, it is possible to beep the ALTA vertical speed reference.

When ALT four-axis AFCS mode is engaged, it is possible to beep the ALT reference.

LEFT/RIGHT COLLECTIVE BEEPS

When an AP is engaged and the aircraft is at a low speed, it is possible to beep the heading hold reference.

When an AP is engaged and the aircraft is at a high speed, it is possible to beep the lateral acceleration reference (ball trim).

5TH POSITION CYCLIC BEEP

When HOV mode is engaged and coupled, it is possible to zero the HOV longitudinal and lateral velocity references by pushing the cyclic beep switch. When HOV mode is not engaged, but engaged conditions are satisfied, pushing the cyclic beep switch engages HOV mode.

AFCS Mode Limits

Table 8-4 lists the mode limits and reference beep rates.

Table 8-4
AFCS Mode Limits

Mode	Control or Sensor	Parameter	Value
Pitch ATT Hold	AHRS	Pitch ref limit Pitch beep rate	±35 degrees <120 knots: ±2 deg/sec >140 knots ±2 deg/sec 120 to 140 knots: ±2 to 1 deg/sec
Roll ATT Hold	AHRS	Roll ref limit Roll beep rate	±60 degrees ±3 deg/sec
Roll HDG Hold (ATT)	AHRS	Roll angle limit (hands off) Roll rate limit	±10 degrees ±4 deg/sec
Yaw Control (ATT/SAS)	AHRS (yaw rate, heading, roll att, lateral acceleration)	Yaw command rate limit Yaw heading beep rate Slip beep rate Slip beep limit	±12 deg/sec ±3 deg/sec ±0.5 ft/s^2/sec ±5 ft/s^2
Any Flight Director Mode	Various	Pitch command limit Pitch rate command limit Roll command limit Roll rate command limit Collective command limit Collective command rate limit	±8 degrees ±2 deg/sec ±35 degrees ±4 deg/sec 100% control 5%/sec

Table 8-4 (cont)
AFCS Mode Limits

Mode	Control or Sensor	Parameter	Value
Heading Select	Heading select knob	Roll angle limit Roll rate limit Beep rate	$\pm$standard rate turn $\pm$4 deg/sec 3 dps for 3 sec then 10 dps
VOR	Course knob, NAV receiver, and DME receiver	<u>Capture</u> Roll angle limit Roll rate limit Course cut limit at cap <u>On Course</u> Roll angle limit Roll rate limit Crosswind correction <u>Over Station</u> Roll angle limit Roll rate limit	$\pm$24 degrees $\pm$3 deg/sec f(TAS) $\pm$24 degrees $\pm$3 deg/sec Up to $\pm$45 deg course error $\pm$24 degrees $\pm$3 deg/sec
VOR APP	Course knob, NAV receiver, and DME receiver	<u>Capture</u> Roll angle limit Roll rate limit Course cut limit at cap <u>On Course</u> Roll angle limit Roll rate limit Crosswind correction <u>Over Station</u> Roll angle limit Roll rate limit	$\pm$24 degrees $\pm$3 deg/sec f(TAS) $\pm$24 degrees $\pm$3 deg/sec Up to $\pm$45 degrees course error $\pm$24 degrees $\pm$3 deg/sec

Table 8-4 (cont)
AFCS Mode Limits

Mode	Control or Sensor	Parameter	Value
LOC or BC	Course knob and NAV receiver	LOC Capture Roll angle limit Roll rate limit Course cut limit at cap On Course Roll angle limit LOC track roll rate limit Roll rate limit Crosswind correction	±22 degrees ±3 deg/sec f(TAS) ±20 degrees ±3 deg/sec ±3 deg/sec Up to ±45 degrees course error
GS	GS receiver and air data sensor	LOC track pitch angle limit	10 deg pitch up 10 deg pitch down capture GS 3 deg pitch down track GS 0.2 g rate limit
Long Range NAV or LNAV	LRN or Honeywell FMS	Roll angle limit Roll rate limit	±30 deg ±4 deg/sec
VGP	Honeywell FMS	Pitch angle limit	10 deg pitch up 10 deg pitch down capture VGP 3 deg pitch down track VGP 0.1 g rate limit
GA	Air data sensor		.10 g rate limit (4-axis) .20 g rate limit (3-axis)

Table 8-4 (cont)
AFCS Mode Limits

Mode	Control or Sensor	Parameter	Value
ALT hold	Air data sensor	Capture limit Beep rate ALT ref limits	0.05 g 50 fps -2,000 to +20,000 ft
ALTA	Air data sensor	VS beep rate G load during capture ALT SEL knob rate ALT ref limits	±150 ft/min/sec 0.1g 50 ft per tick (slow rate), 200 ft per tick (fast rate) -2,000 to + 20,000 ft
VS hold	Air data sensor	VS beep rate	±150 ft/min/sec .10 g rate limit (4-axis) .20 g rate limit (3-axis)
IAS hold	Air data sensor	IAS beep rate	±3.5 knots/sec
ILS DCL	Air data sensor	Deceleration limit	0.2 g max
VGP DCL	Air data sensor	Deceleration limit	0.2 g max
RHT	Radio altitude	Beep rate	4 fps for 5 seconds then 16 fps (when below 250 ft) 20 fps for 5 seconds then 80 fps (when 250 ft or greater)
HOV	AHRS	Beep rate	±3.5 knots/sec

AFCS Annunciator

The AFCS generates several types of annunciators for status, reference and alerting purposes. The annunciator can be displayed in one of four ways.

- Primary flight display (PFD)
- Cockpit annunciators
- Multifunction display (MFD) AFCS page
- Crew alerting system (CAS).

PFD ANNUNCIATOR

The following AFCS related information is displayed on the PFD:

- Flight director commands (cues) and status
- Navigation data source selection
- Armed and engaged flight director modes and references
- Autopilot status.

The PFD uses information transmitted by the AFCS to display the annunciators listed above. Each annunciator is detailed in the following paragraphs.

FLIGHT DIRECTOR COMMANDS AND STATUS

Under normal conditions, each PFD shows flight director command bars, mode annunciators, and mode references from its on-side flight director. The PFD source select arrow, located above the attitude sphere on each PFD, indicates the status of the on-side flight director.

AUTOPILOT STATUS

When the autopilot is uncoupled from an active flight director mode (by way of the **CPL** button on the AP controller), the UCPL annunciator is displayed on the PFD. When both autopilots are completely disengaged, and a flight director mode is engaged, the UCPL annunciator is displayed on the PFD.

NOTE: The UCPL annunciator is not removed because of failed AP axes.

The UCPL annunciator is not present when accelerometer-based HOV mode is the active flight director mode. Similarly, when the autopilot has SAS mode engaged, a SAS annunciator is present on the PFD.

When the collective trim switch is turned OFF when an AP is engaged the CLTV annunciator is displayed on the PFD.

When conditions for more than one of the three PFD annunciators (UCPL , SAS and CLTV) are met, the display presents the annunciator with the highest priority. The priority for these PFD messages are SAS (highest), UCPL and CLTV (lowest).

CREW ALERTING SYSTEM (CAS)

The AFCS is responsible for generating CAS messages to inform the crew of non-normal states of operation. The message characteristics are determined by the AFCS. The characteristics of each message is determined by the message color and the length of time that the message is displayed on EICAS. The AFCS has the capability to display two types of messages:

- Displayed as long as the message flag is active
- Timed out after five seconds.

AFCS MESSAGES

Table 8-5 includes the list of AFCS messages. All messages in the form, 1-2 MESSAGE can be any of three messages:

- 1 MESSAGE
- 2 MESSAGE
- 1-2 MESSAGE .

These messages are dependent on whether the problem is on system 1, system 2, or both systems.

All of the CAS messages in Table 8-5 are displayed when the message conditions are present (except that the last eight messages are present for five seconds after the associated guidance controller button is pushed).

Table 8-5
AFCS Messages

Message	Conditions
1-2 AP OFF	Autopilot disengaged
1-2 P AP OFF	Pitch axis autopilot disengaged
1-2 R AP OFF	Roll axis autopilot disengaged
1-2 Y AP OFF	Yaw axis autopilot disengaged
1-2 TRIM FAIL	All trim axes are failed
1-2 P TRIM FAIL	Pitch trim axis is failed
1-2 R TRIM FAIL	Roll trim axis is failed
1-2 Y TRIM FAIL	Yaw trim axis is failed
1-2 AP FAIL	All axes autopilot failed
1-2 P AP FAIL	Pitch axis autopilot failure
1-2 R AP FAIL	Roll axis autopilot failure
1-2 Y AP FAIL	Yaw axis autopilot failure
1-2 COLL FAIL	Collective axis autopilot failure
ATT OFF	Attitude mode is OFF
MISTRIM	Pitch and/or roll axes are out of trim
AFCS DEGRADED	There have been system failures that have eliminated the required redundancy. The airspeed must be reduced to 120 knots
1-2 SAS DEGRADED	There have been system failures that affect SAS performance (for example, loss of cyclic position)

Table 8-5 (cont)
AFCS Messages

Message	Conditions
DCL NOT INSTALLED	DCL button pushed while aircraft was configured as a three-axis AFCS
ALTA NOT INSTALLED	ALTA button pushed while aircraft was configured as a three-axis AFCS
RHT NOT INSTALLED	RHT button pushed while aircraft was configured as a three-axis AFCS
HOV NOT INSTALLED	HOV button pushed
VNAV NOT INSTALLED	VNAV button pushed when aircraft is not configured to support VNAV flight director mode
TD NOT INSTALLED	TD button pushed when aircraft is not configured as a SAR flight director aircraft
MOT NOT INSTALLED	MOT button pushed when aircraft is not configured as a SAR flight director aircraft
WTR NOT INSTALLED	WTR button pushed when aircraft is not configured as a SAR flight director aircraft

COCKPIT ANNUNCIATORS

There are no AFCS-related cockpit annunciators beyond those on the autopilot controller and the guidance controller.

AP DISCONNECT AURAL

The following conditions control the presentation of an autopilot aural (AP aural):

- The AP aural does not occur on the ground.
- The AP aural does not require an ON$\geq$OFF transition of the AP (such as, when the pilot takes off without engaging both APs, the aural sounds as soon as the aircraft is in the air).

- The AP aural occurs for any combination of pitch, roll, or yaw disengagements.
- After the AP aural has occurred for one AP OFF/FAIL condition, it does not reoccur until the AP is engaged/re-engaged (such as, when the AP1 pitch axis drops off and the pilot subsequently gets the AP aural, 30 seconds later the AP1 roll axis drops off, the pilot does not get an additional AP aural).
- After an AP aural has occurred, an additional AP aural (for the other autopilot) does not occur unless the new failure condition is recognized more than five seconds after the first AP aural (such as, first AP1 drops off and two seconds later AP2 drops off, the AP aural from the AP1 drop-off is heard.).

AFCS MODE CHANGE TONE

There are four conditions that result in an AFCS mode change tone (the tone):

- Flight director mode changes
- SAS/ATT toggling
- Flight director/AP coupling changes
- CLTV toggling.

The tone is triggered when a lateral, vertical (pitch), or vertical (collective) flight director mode transitions from its previous state. The tone is triggered by the initial engagement of the flight director mode when the flight director was previously in STBY mode.

NOTE: Arming of modes does not trigger the tone. The tone is triggered by the transition from an engaged flight director mode to standby. In addition, the tone is triggered by the toggling between SAS and ATT and toggling the flight director from coupled to uncoupled. When a flight director mode is engaged and coupled, the tone is triggered by the transition of the CLTV switch to OFF and from flight director coupled to uncoupled.

After a tone has occurred, an additional tone (for another condition) does not occur unless the new condition occurs more than 0.5 seconds after the initial tone. When the additional tone is due to a GA disengagement, the second tone is permitted without any delay.

Blank Page

9. Vehicle Monitoring System (VMS)

INTRODUCTION

The VMS monitor/warning system monitors helicopter systems and functions for normal operations and failure. The system operates continuously when powered up, alerting the pilot to conditions of the monitored systems. The means of alert are color coded messages annunciated in the crew alert system (CAS) message queue and aural signals.

The modular avionics units (MAU) continuously monitors engine and aircraft systems commanding the CAS to present WARNING, CAUTION, ADVISORY, and STATUS messages to the CAS message queue as they are determined to be necessary.

Unless otherwise specified, all the input and output signals are shared between each MAU in order to achieve the required redundancy level.

Each MAU supplies interfaces to the following remote components:

- Primary flight displays (PFD)
- Multifunction display (MFD)
- Two electronic engine controls (EEC)
- Two master warning/caution lights, one at each pilot station
  - — Master warning light (MWL) red
  - — Master caution light (MCL) amber
- Fuel computer unit (FCU)
- Transmission chip detector unit.

The CAS message queue shows up to 12 messages with as many as 18 characters in each message.

During an automatic or manual reversion event, the composite primary flight display (PFD) mode repeats the same CAS message queue as the MFD.

Along with CAS messages, the aural warning generator (AWG) generates aural messages spoken in plain language and tones audible to the crew as conditions dictate.

The comparison monitoring function of the MAU continuously compares digital engine parameters to the analog engine parameters to identify failures.

The central maintenance computer (CMC) records all exceedance data, fault data, cumulative data, and associated CAS messages that occur during flight operations.

The VMS monitor/warning system of the AW139/AB139 helicopter consists of the following components:

- Two primary flight display (PFD)
- Two multifunction display (MFD)
- Two modular avionics units (MAU)
- Two display controllers (DC) for PFD mode management
- Two cursor control devices (CCD) for MFD mode management
- Two remote instrument controllers (RIC) one for each PFD
- Reconfiguration control panel (RCP).

AURAL MESSAGES AND TONES

Along with CAS messages, an AWG generates a series of aural messages that are listed in Table 9-1. Some of the aural messages are preceded by tones. The messages and tones are audible through the helicopter ICS system and are designed to alert the pilots to conditions that require immediate action. Aural messages associated with the TAWS are described in Section 19, Terrain Alert Warning System (TAWS), of this guide.

Table 9-1
Aural Messages and Tones

Priority	Aural Message	Number of Cycles
1	**ROTOR LOW-ROTOR LOW**	Continuous
2	**ENGINE (X) OUT-ENGINE (X) OUT**	1
3	**ENGINE (X) FIRE-ENGINE (X) FIRE**	Continuous
4	**ROTOR HIGH-ROTOR HIGH**	1
5	**ENGINE (X) IDLE-ENGINE (X) IDLE**	Continuous
6	**WARNING WARNING**	1

Table 9-1 (cont)
Aural Messages and Tones

Priority	Aural Message	Number of Cycles
7	AUTOPILOT AUTOPILOT	1
8	AIRSPEED AIRSPEED	1
9	FLIGHT DIRECTOR MODE CHANGE CHIME	1
10	FLIGHT DIRECTOR REFERENCE CHANGE CHIME	1
11	ALTITUDE ALTITUDE	1
12	TRAFFIC TRAFFIC	1
13	TRAFFIC	1
14	TCAS SYSTEM TEST OK	1
15	TCAS SYSTEM TEST FAIL	1
16	LANDING GEAR	1
17	150 FEET	1
18	AURAL SYSTEM TEST	1
*	PULL UP	1
*	TERRAIN TERRAIN	1
*	WARNING! TERRAIN	1
*	WARNING! OBSTACLE	1
*	TERRAIN	1
*	CAUTION TERRAIN	2
*	CAUTION OBSTACLE	2
*	TOO LOW TERRAIN	1
*	SINKRATE	1
*	DON’T SINK	2
*	GLIDESLOPE	1

Table 9-1 (cont)
Aural Messages and Tones

Priority	Aural Message	Number of Cycles
*	BANK ANGLE	2
*	TAIL TOO LOW	1
*	BE ALERT TERRAIN INOP	1
*	TOO LOW GEAR	1
*	TWO HUNDREDS **	1
*	ONE HUNDRED **	1
*	EIGHTY **	1
*	SIXTY **	1
*	FORTY **	1
*	TWENTY **	1
*	TEN **	1

NOTE: **(X)** Represents either No. 1 or No. 2 Engine as necessary.
***** Represents TAWS (EGPWS) has the same priority of the VMS aural warning and both have priority over TCAS aural alerts.
****** Represents that the respective message can become active in Autorotation mode only.

WARNING-WARNING is generated when any WARNING condition is detected. The exception is the following failure conditions which are characterized by dedicated aural signals.

- **ENGINE 1 FIRE or ENGINE 2 FIRE**
- **ENGINE 1 OUT or ENGINE 2 OUT**
- **ROTOR HIGH**
- **ROTOR LOW**
- **ENGINE 1 IDLE - ENGINE 1 IDLE**
- **ENGINE 2 IDLE - ENGINE 2 IDLE.**

These aural warning messages are sounded continuously until the failure condition is corrected or the system is reset by pushing either the MASTER WARNING annunciator or the master CAS reset button.

- **ROTOR LOW-ROTOR LOW**
- **ENGINE 1 FIRE-ENGINE 1 FIRE**
- **ENGINE 2 FIRE-ENGINE 2 FIRE**
- **ENGINE 1 IDLE - ENGINE 1 IDLE**
- **ENGINE 2 IDLE - ENGINE 2 IDLE.**

Aural warning messages are generated in the order of their occurrence. If a higher priority message is activated while a lower priority message is being generated, the higher priority message does not pre-empt the message being sounded. The higher warning message queues and is sounded when the current message ends.

In any case, an aural message completes at least one intelligible cycle before being terminated. The **AWG FAIL** CAS message is displayed when the AWG fails.

Aural Warning Generator (AWG) Test

The **AWG TEST** button is located on the systems test panel.

A single short push of the **AWG TEST** button activates the **AURAL SYSTEM TEST** message for one cycle.

Pushing and holding the **AWG TEST** button for six seconds activates all the aural messages and tones in the priority order shown in Table 9-1. Each message is generated once in TEST.

Comparison Monitoring

In order to provide the required level of data integrity required by regulations, the monitoring warning system monitors certain display data, listed in Table 9-2, and provides an indication on the ASCB when there is a disagreement between the data sources.

Table 9-2
Miscompare Parameters

Miscompare Parameter	Trip Threshold
Pitch	± 5 degrees
Roll	± 6 degrees
Heading	±10 degrees
Pressure Altitude	±150 feet
Barometric Altitude	±150 feet
Indicated Airspeed	±20 knots
LOC Lateral Deviation	±40 microamps
LOC Vertical Deviation	±50 microamps
VNE	±7 knots
Radar Altitude	±0.9375*(7ft + 0.0625*(|radar_Altitude1| + |radar_Altitude2|))ft

The data source monitoring is inhibited under the following circumstances:

- The miscompare monitor of the LOC lateral deviation and LOC vertical deviation are performed when both primary navigation sources are localized.
- The miscompare monitor of the ILS vertical deviation is inhibited when the back course lateral flight director mode is armed or captured.

FLIGHT DISPLAYS

Both the primary and multifunction flight displays are used by the VMS to supply the pilots with essential elements of information.

When the PFD or MFD fails, the automatic display reversion capability shows a composite of essential flight information on the PFD. The pilot can manually select the composite PFD display mode using the reversion control panel.

Primary Flight Display (PFD)

The PFD shows primary flight information in the windows, as shown in Figure 9-1. A detailed description of the PFD functions are described in Section 5.

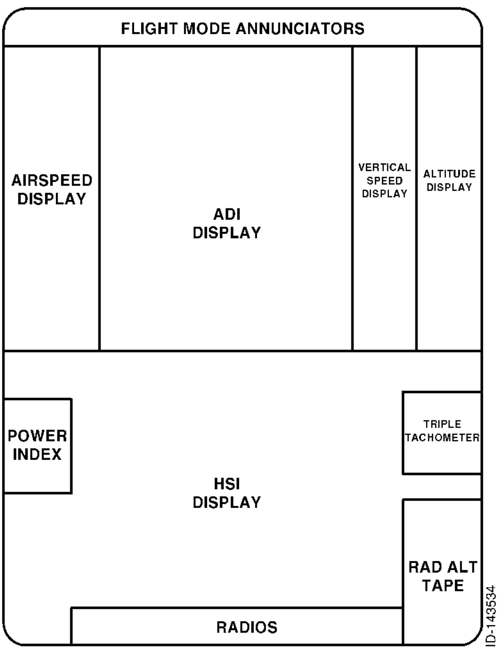


Figure 9-1
PFD Window Breakdown

The triple tachometer (tritach) and the power index (PI) gauge are positioned in the horizontal situation indicator (HSI) segment of the PFD. Both supply essential VMS indications.

The tritach monitors power turbine speed (NF) of both the No. 1 and No. 2 engine along with main rotor speed (NR).

The PI gauge monitors compressor speed (NG), internal turbine temperature (ITT) and torque (TQ) of both engines for operation within design limitations. The PI shows the condition of the system that is closest to reaching its operational limit. This is done by comparing the condition of the three monitored systems.

Composite Primary Flight Display (PFD)

The automatic display reversion of the system combines essential flight information from a failed display unit onto a functioning display forming a composite PFD display. Using the composite display, the flight can continue.

Using manual display reversion, the pilot can combine essential flight information from a failed display unit onto a functioning display forming a composite PFD. Reversion conditions exist when an MFD or PFD is rendered inoperative.

When a reversion condition exists and the auto or manual reversion is activated, the composite PFD mode generates a CAS message window in the center of the HSI segment of the PFD display, as shown in Figure 9-2.

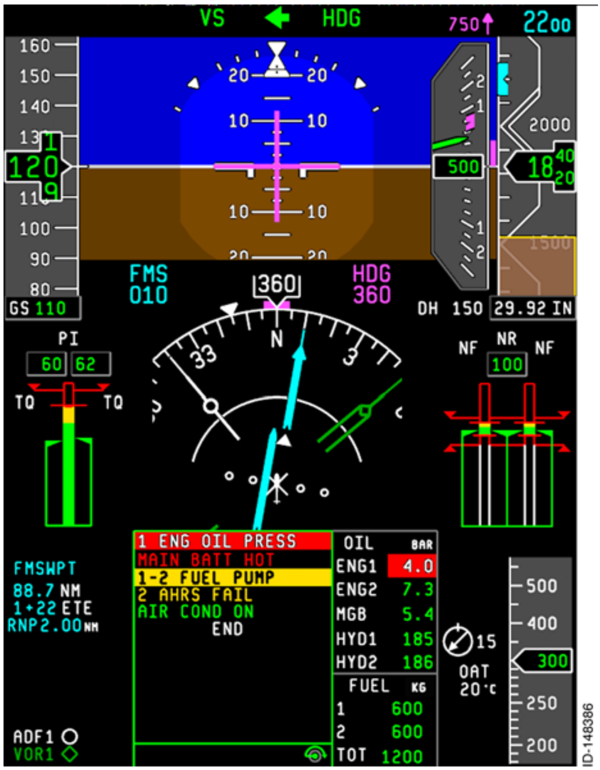


Figure 9-2
Composite PFD

Composite Primary Flight Display (PFD) Presentation

When a reversion condition exists, the composite PFD shows reduced VMS information. In this case, along with CAS messages, the following items of information are displayed.

SECONDARY ENGINE INDICATIONS

- Engine oil pressure
- Main gearbox oil pressure
- Hydraulic oil pressure
- Fuel quantity.

ANALOG INDICATIONS

- Power index (PI) gauge
- Turbine speed (NF)
- Rotor speed (NR).

DIGITAL INDICATIONS

- Limiting engine parameter (NG, ITT, or TQ) on PI gauge
- NR
- No. 1 and No. 2 engine oil pressure
- Main gear box (MGB) oil pressure
- No. 1 and No. 2 hydraulic pressure
- No. 1 and No. 2 fuel quantity
- Up to 12 CAS messages.

NOTE: On ground, the PFD shows the AEO mode information.

Multifunction Display

When the main page, shown in Figure 9-3, is in use, the MFD screen shows two different windows. They are described in the following paragraphs. A detailed description of the MFD functions are described in Section 6 Multifunction Display (MFD).

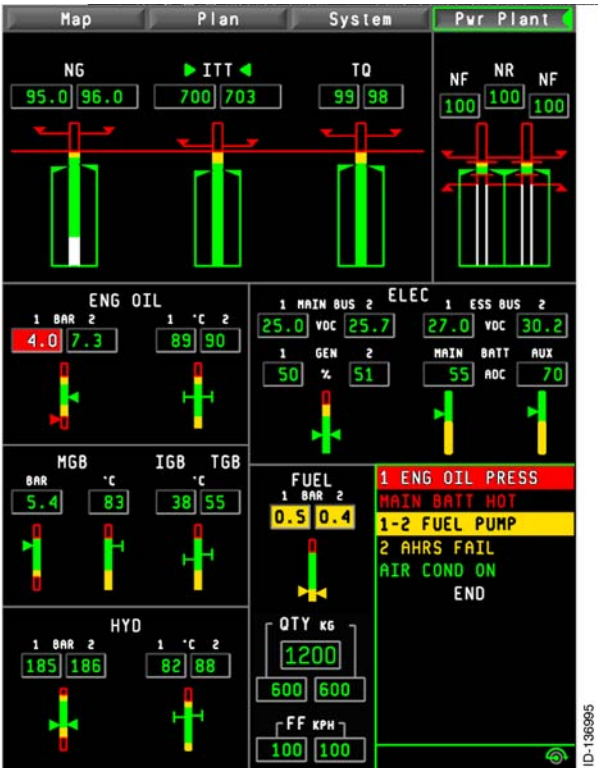


Figure 9-3
MFD MAIN PAGE Default Display

MAIN PAGE

When the main page is selected, the MFD screen area is presented in two different (partitioned) windows, as shown in Figure 9-4.

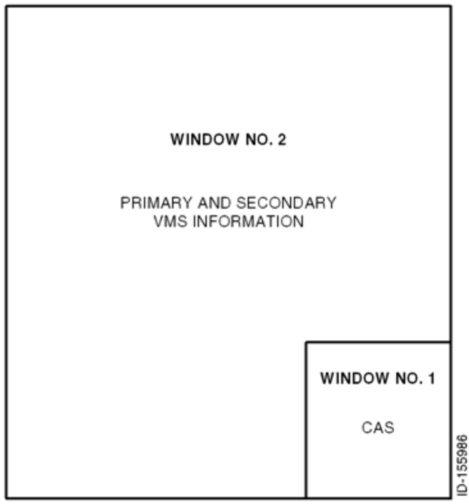


Figure 9-4
MFD Showing Main Page Windows

Window number one in the lower right corner of the MFD main page is the permanent CAS message display and is never suppressed in any flight condition.

Window number two in the top half of the MFD main page shows the primary and secondary engine and systems information.

This page is used to monitor the engine start or assess the overall condition of engines and helicopter systems.

Four different flight conditions with the following associated engine ratings can be monitored.

- All engines operating (AEO) mode
- One engine inoperative (OEI) mode
- One engine inoperative, (OEI) training mode
- Autorotation mode.

NOTE: Engine ratings are described in detail in the following primary VMS indications.

CRUISE PAGES

When one of the following CRUISE pages are selected, the MFD screen area is presented in three different partitioned windows, as shown in Figure 9-5.

There are six CRUISE pages available for selection:

- MAP
- PLAN
- VIDEO
- DC ELEC
- ICE PROTECTION
- FLIGHT CONTROLS.

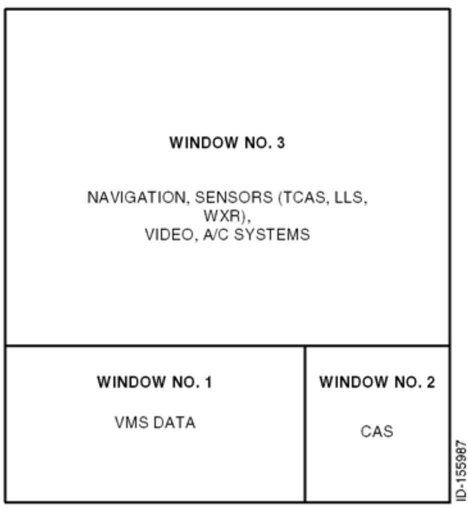


Figure 9-5
MFD CRUISE PAGES Window Breakdown

WINDOW NUMBER 1 shows the primary or secondary VMS information that relates to the selected engine rating.

WINDOW NUMBER 2 is the permanent CAS message display. It operates the same as the CAS message display in the main page.

WINDOW NUMBER 3 shows one of the following system pages that can be manually selected by the pilot:

- FLIGHT CONTROLS

- HYDRAULIC
- DC ELECTRICAL
- MAINTENANCE (ground use only)
- ICE PROTECTION (option)
- SYSTEM CONFIGURATION (ground use only).

WINDOW NUMBER 3 permits selection of the following menu items:

- CALIBRATION (option)
- CONFIGURATION (units and clock set).

Crew Alert System (CAS) Messages

Each CAS message is associated with a specific system. Listed in the following paragraphs are the CAS messages grouped in the order of their priority and identified with their respective system.

Warning Messages

The transmission, the electrical system and the engines are restricted to given ranges of operation for safety. If these ranges are exceeded, a warning message is identified. WARNING messages are all identified with one of the following four systems.

- Engine
- Transmission
- Electrical
- Miscellaneous (for example, bag fire and de-ice).

The 20 WARNING messages are outlined in the following paragraphs.

NOTE: Any WARNING message presented in the queue is automatically recorded in the CMS fault log.

ENGINE WARNING MESSAGES

1 ENG FIRE – Fire detected by the number one engine fire detection system.

2 ENG FIRE – Fire detected by the number two engine fire detection system.

1 ENG OUT – Number one engine has failed.

2 ENG OUT – Number two engine has failed.

1 EEC FAIL – Number one electronic engine control has failed.

2 EEC FAIL – Number two electronic engine control has failed.

1 ENG OIL PRESS – Number one engine oil pressure warning.

2 ENG OIL PRESS – Number two engine oil pressure warning.

1 ENG IDLE – Number one engine idle warning (active on the ground).

2 ENG IDLE – Number two engine idle warning (active on the ground).

TRANSMISSION WARNING MESSAGES

ROTOR HIGH **MGB OIL PRESS**

ROTOR LOW **MGB OIL TEMP**

ELECTRICAL WARNING MESSAGES

MAIN BATT HOT **1-2 DC GEN**

AUX BATT HOT **AUX-MAIN BATT HOT**

MISCELLANEOUS WARNING MESSAGES

BAG FIRE **DE-ICE**

Caution Messages

CAUTION messages are all identified with a specific system.

The **CAUTION** messages are outlined in the following paragraphs.

NOTE: Any exceedance limit that results in a **CAUTION** message in the queue is automatically recorded in the CMS exceedance log.

ENGINE CAUTION MESSAGES

1 ENG OIL TEMP **1 EAPS PRESS**

2 ENG OIL TEMP **2 EAPS PRESS**

1 ENG CHIP **1 EEC DATA**

2 ENG CHIP **2 EEC DATA**

1 FIRE DET **1 HOT START**

2 FIRE DET **2 HOT START**

1 ECL FAIL **1 ITT LIMITER**

2 ECL FAIL **2 ITT LIMITER**

1 ECL POS **1 TQ LIMITER**

2 ECL POS
1 ENG MODE SEL
2 ENG MODE SEL
1 OVSPD
2 OVSPD
1 OVSPD DET
2 OVSPD DET
2 TQ LIMITER
RPM SELECT
1 ENG LIM EXPIRE
2 ENG LIM EXPIRE
1 DCU
2 DCU

FUEL SYSTEM CAUTION MESSAGES

1 FUEL LOW
2 FUEL LOW
1 FUEL LOW FAIL
2 FUEL LOW FAIL
1 FUEL PROBE
2 FUEL PROBE
1 FCU FAIL
2 FCU FAIL
1 FUEL FILTER
1 FUEL HEATER
2 FUEL HEATER
1 FUEL ICING
2 FUEL ICING
1 FCU TEST FAIL
2 FCU TEST FAIL
1 FUEL PUMP
2 FUEL PUMP
2 FUEL FILTER

ELECTRICAL SYSTEM CAUTION MESSAGES

1 DC GEN
2 DC GEN
1 DC GEN HOT
2 DC GEN HOT
BUS TIE OPEN
EXT PWR DOOR
MAIN BATT OFF
AUX BATT OFF
DC BUS FAIL
1 AC GEN BUS
2 AC GEN BUS
BATT OFF LINE
1 INV
2 INV
1 INV HOT
2 INV HOT
1 AC GEN
2 AC GEN
1 AC GEN HOT
2 AC GEN HOT
1 AC OVERLOAD
2 AC OVERLOAD

AVIONICS SYSTEM CAUTION MESSAGES

1 AP OFF
2 AP OFF
1 P AP OFF
1 VHF COM OVHT
2 VHF COM OVHT
1 DU OVHT

2 P AP OFF
1 R AP OFF
2 R AP OFF
1 Y AP OFF
2 Y AP OFF
1 TRIM FAIL
2 TRIM FAIL
3 DU DEGRADED
4 DU DEGRADED
1 MAU OVHT
2 MAU OVHT
1 MCDU OVHT
2 MCDU OVHT
1 MRC OVHT
2 MRC OVHT
SYS CONFIG FAIL
VALIDATE CONFIG
1 AUDIO FAIL
2 TQ MISCOMPARE
2 AUDIO FAIL
ENG ANALOG FAILURE
VNE MISCOMPARE
AVIONIC FAULT
1 FMS/GPS MSCP
FMS/GPS MSCP UNAVL
1 P TRIM FAIL
1 R TRIM FAIL
1 Y TRIM FAIL
1 AP FAIL
1 P AP FAIL
1 R AP FAIL
1 Y AP FAIL
ATT OFF
1 COLL FAIL
AFCS DEGRADED

2 DU OVHT
3 DU OVHT
4 DU OVHT
1 DU DEGRADED
2 DU DEGRADED
1 AHRS FAIL
2 AHRS FAIL
1 ADS FAIL
2 ADS FAIL
NR MISCOMPARE
1 NF MISCOMPARE
1 NG MISCOMPARE
1 ITT MISCOMPARE
1 TQ MISCOMPARE
2 NF MISCOMPARE
2 NG MISCOMPARE
2 ITT MISCOMPARE
WX TRANSMITTING
CVR FAIL
2 FMS/GPS MSCP
FDR FAIL
2 P TRIM FAIL
2 R TRIM FAIL
2 Y TRIM FAIL
2 AP FAIL
2 P AP FAIL
2 R AP FAIL
2 Y AP FAIL
MISTRIM
2 COLL FAIL
1 SAS DEGRADED

2 SAS DEGRADED
GPS FAIL
2 FMS FAIL
AWG FAIL
1 FMS FAIL

TRANSMISSION CAUTION MESSAGES

MGB CHIP MAST
MGB CHIP SUMP
IGB CHIP
TGB CHIP
CHIP DET UNIT
CHIP DET TEST
CHIP MAST FAIL
CHIP SUMP FAIL
IGB CHIP FAIL
TGB CHIP FAIL
IGB OIL TEMP
TGB OIL TEMP
MGB OIL FILTER
1 MGB OIL PRESS
2 MGB OIL PRESS
MGB OIL LOW
IGB OIL LOW
TGB OIL LOW
1 BRG TEMP
2 BRG TEMP
XMSN OVTQ

HYDRAULIC CAUTION MESSAGES

1 HYD OIL PRESS
2 HYD OIL PRESS
EMER LDG PRESS
HYD UTIL PRESS
1 HYD OIL TEMP
2 HYD OIL TEMP
1 HYD PUMP
2 HYD PUMP
4 HYD PUMP
1 HYD MIN
2 HYD MIN
1 SERVO
2 SERVO
NOSE WHL UNLK
ROTOR BRK FAIL

MISCELLANEOUS CAUTION MESSAGES

PARK BRK PRESS
FLOAT ARM
HOOK OPEN
ICING
1 PITOT FAIL
1 PITOT HEAT OFF
AFT COND FAIL
VENT FAIL
PARK BRK ON
HOOK ARM
LANDING GEAR
DE ICE
2 PITOT FAIL
2 PITOT HEAT OFF
FWD COND FAIL
HEATER FAIL

COCKPIT DOOR
CABIN DOOR
BAG DOOR
NOSE DOOR
1 WOW FAIL
2 WOW FAIL
HOIST CUT ARM
HOIST CBL FOUL
SEC HOOK ARM
1 WSHLD HTR FAIL
2 WSHLD HTR FAIL
1 WSHLD HTR DEGR
2 WSHLD HTR DEGR
FIRE BUCKET ARM

Advisory Messages

ADVISORY messages are all identified with a specific system. The 34 ADVISORY messages are outlined in the following paragraphs.

ENGINE ADVISORY MESSAGES

1 EAPS ON
TQ LIMITER ON
2 EAPS ON

FUEL ADVISORY MESSAGES

FUEL XFEED

ELECTRICAL SYSTEM ADVISORY MESSAGES

EXT PWR READY
EXT PWR ON

HYDRAULIC SYSTEM ADVISORY MESSAGES

ROTOR BRK ON

MISCELLANEOUS ADVISORY MESSAGES

LANDING LT ON
PARK BRK ON
SEARCH LT ON
LDG EMER DOWN
STEP EXTD
HOIST ON
1 PITOT HEAT ON
FORCE TRIM OFF
2 PITOT HEAT ON
CLTV/YAW OFF
OXYGEN CLOSED
HEATER ON
AIR COND ON
AFT VENT
FWD VENT
1 WSHLD HTR ON
2 WSHLD HTR ON
STROBE LT ON

AVIONICS ADVISORY MESSAGES

DCL NOT INSTALLED
WX NOT INSTALLED

ALTA NOT INSTALLED

RHT NOT INSTALLED

HOV NOT INSTALLED

CAT A DISP INHIBIT

TAWS AUDIO MUTE

TAWS GS CANCEL

TAWS LOW ALT

Status Messages

STATUS messages are all identified with a specific system. The STATUS messages are listed as follows:

MAINTENANCE

TAWS AUDIO MUTE

TAWS GCS CANCEL

TAWS LOW ALT

10. Radio System

INTRODUCTION

A block diagram of the Honeywell PRIMUS EPIC system for the IFR version of the Agusta AW139/AB139 Helicopter is shown in Figure 10-1.

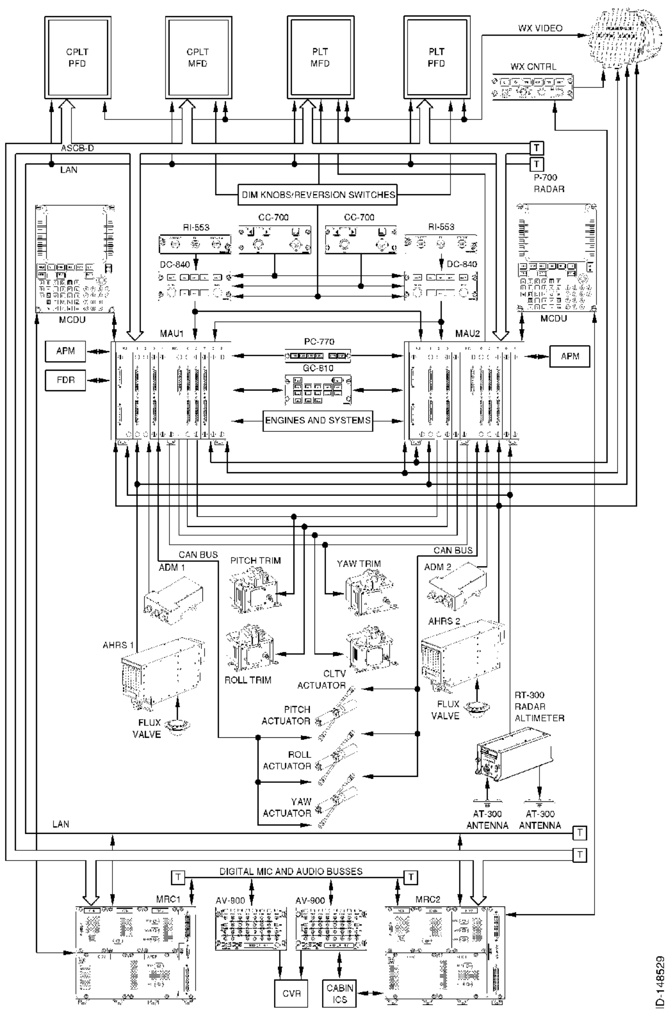


Figure 10-1
System Block Diagram

The communication and navigation functions given by the PRIMUS EPIC avionics system include:

- ICS
- Very high frequency (VHF) communication
- VHF omnirange (VOR)/instrument landing system (ILS) navigation
- Distance measuring equipment (DME) navigation
- Automatic direction finding (ADF) navigation
- Global position system (GPS) (option)
- Attitude and heading reference system (AHRS)
- Transponder (XPDR)
- Radio altitude system (option: dual configuration)
- Controllers
- Weather radar system (option)
- Lightning sensor system (option).

SYSTEM ELEMENTS

Modular Radio Cabinet

The core of the communication and navigation system is the modular radio cabinet (MRC). The MRC is the integrated radio cabinet that houses multiple line replaceable modules providing aircraft radio functions. The network interface module (NIM) in each MRC communicates to the rest of the PRIMUS EPIC system by way of the ASCB-D and LAN networks. Flight data is transmitted by way of the ASCB, and the LAN is used for maintenance and data loading purposes.

The radio modules include the following:

- ADF module
- DME module
- COM module
- NAV module
- XPDR module.

Each radio module consists of metal-enclosed circuit cards, backplane connectors and front mounting plate with a front connector(s). Each radio module contains its own power supply as this permits independent application of aircraft power to the modules. Each radio module contains self-test circuitry that can be activated as an initiated built-in test (IBIT) through the maintenance page of the CMC. The layout of the AW139/AB139 modular radio cabinets is shown in Figure 10-2.

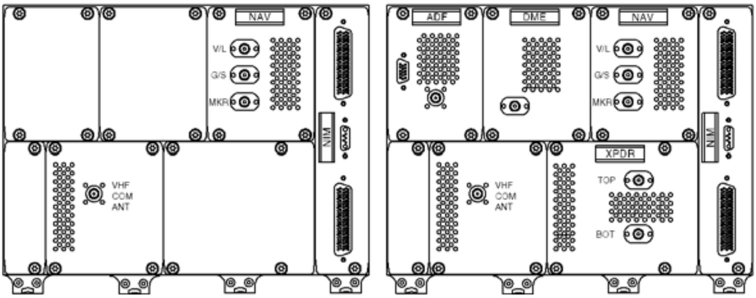


Figure 10-2
Modular Radio Cabinets

NIM MODULE

The NI-900 NIM is a line replaceable module (LRM) in the PRIMUS EPIC MRC. The NIM connects internally to the radio modules by a passive serial backplane on the RS-422.

The NI-900 contains a standard 10-base-2 LAN interface, supplied on each NIC for routine, non-critical data transfers. The LAN network is connected by thin 50 ohm coax through a coaxial insert in each sub-D connector.

The NI-900 performs two functions. It gives a central processor and an interface between other aircraft systems and the MRC radio modules.

The NIM interfaces with the ASCB using the standard NIC circuit used on all other ASCB-connected units. The central processor section of the NIM uses an AMD 486 DX5 (architecture is similar to Intel 80486 processor), DEOS and PRIMUS EPIC core software components. This section processes commands from the ASCB-D, (such as radio tuning commands), formats all RF module data for transmission on the ASCB-D, and performs various additional tasks such as audio data handling.

The NIM connects internally to the radio modules by individual cable harnesses within the MRC cabinet.

The NI-900 NIM commands and reports status of frequency, channel, code, and mode as appropriate for each of the following radios by way of the ASCB:

- VHF digital radio (VDR) 1
- VDR 2
- VOR/ILS datalink (VIDL)1

- VIDL 2
- DME 1 (option)
- DME 2
- ADF 1 (option)
- ADF 2
- XPDR 1 (option)
- XPDR 2.

The NI-900 NIM transmits navigation data from the VIDL, DME, and ADF radios by way of the ASCB. It gives analog to digital conversion of radio audio for transmission on the digital audio bus.

The NIM gives four spare analog audio inputs/outputs for audio signals from radios external to the MRC such as a third COM and/or HF radio. It gives microphone audio from the digital microphone bus to the COM radios in the MRC.

The NIM gives digital to analog audio conversion from the digital microphone bus to support analog microphone outputs including the PA system, cabin ICS, and external radios. It gives an interface to the LAN network in the PRIMUS EPIC system.

The NIM can use the LAN for loading software on the RNIC or RPROC processors. It supplies interface for storing and retrieving configuration data in the aircraft personality module (APM) within the MRC.

TR-865 Digital VHF Data Radio (VDR)

The VHF communications system gives two-way, air-to-air, and air-to-ground communication in the frequency range of 118.000 MHz to 136.975 MHz with 8.33 kHz or 25 kHz channel spacing, which is selectable through the MCDU.

The system has an automatic transmit time-out function to prevent blockage of a communication channel when a push-to-talk (PTT) switch is stuck closed. When a NIM fails, an ARINC 429 bus is given to maintain control. An analog audio backup control is available (headphones) by selecting the backup button on the audio panels. This function bypasses the MIC bus in the NIM and audio panels.

NOTE: An alternative TR-866 is available to support an extended tuning range up to 152 MHz.

The VHF COM system consists of the following equipment:

- One VDR module per MRC

- One VDR antenna per module
- One (optional third COM) mini-cabinet with a VDR module connected to the third COM antenna.

NOTE: An option for a third communication system gives data capability. This unit is located in the mini-cabinet and acts as a third COM function.

The VDR supplies the following voice and data radio functions:

- 8.33 kHz channel ARINC 716 compatible analog voice communications transceiver
- 25 kHz channel ARINC 716 compatible analog voice communications transceiver.

The VDR has its own power supply and can operate independent of the NIM. It supplies audio to the NIM for transmission on the digital audio bus.

The VDR has a maintenance log with the faults, software versions and option settings stored in non-volatile memory for shop maintenance. It has a built-in self-test that can be initiated as an IBIT test through the maintenance page of the CMC.

The VDR can operate with 18V minimum operating voltage. It includes transmitter thermal protection. The VDR gives emergency COM tuning frequency of 121.5 MHz.

VDR Options

The TR-865B VDR can be upgraded to support VDL mode A operation.

The TR-865C VDR can be upgraded to support VDL mode two operation and transfer data at rates of 31.5 kb/s in a 25 kHz using D8PSK modulation.

VHF Omnidirectional Radio and Instrument Landing (VIDL) NV-875

The NV-875 VIDL gives VOR/ILS and data link functionality. It includes a marker (MKR) beacon receiver. Frequency control is given to the module by the NIM by way of the cabinet internal radio control buses (RCB). Backup tuning is given by the MCDU by way of a dedicated A429 interface. The VIDL module gives deviation and other output data to the NIM by way of the RCB.

Analog NAV audio signals from the module are digitized by the NIM and transmitted on the digital audio bus. Audio outputs from the VIDL include NAV IDENT and MKR tone signals.

The VHF navigation system enables the following:

- VOR en route flight phase navigation
- Terminal navigational
- Aircraft approach/landing phase navigation guidance using localizer LOC, GS, and MKR BCN distance to runway threshold information.

One dual VOR/LOC antenna is installed on the tail of the aircraft. The VOR/LOC receiver operates over the frequency band from 108.00 MHz to 117.95 MHz in 50 kHz increments and the LOC from 108.10 MHz to 111.90 MHz in 50 kHz increments. The GS receiver operates over the frequency band 329.15 MHz to 335.0 MHz in 150 kHz increments. The receiver system automatically pairs localizer and glideslope channels to assigned frequencies. The marker beacon receiver operates at 75 MHz.

The VHF NAV system consists of the following equipment:

- One VIDL module in each MRC
- One GS antenna with diplexer
- One MKR BCN antenna with a diplexer
- Left and right VOR/LOC antenna with diplexer.

NAV audio signals from the module are routed by the NIM and transmitted on the digital audio bus. NAV IDENT and MKR BCN tone audio signals are transmitted from the digital audio bus to each of the two audio panels in the system. The VIDL has an ARINC 429 backup bus for radio tuning when the NIM fails.

The VIDL is an airborne navigation receiver that operates in ILS or VOR receiver modes. The VIDL gives the following radio functions:

- The VHF omni range receiver gives bearing in degrees TO/FROM the ground station and is used as navigation means for the aircraft.

- The ILS gives approach and landing navigation guidance information. The radio components of this system include the LOC, GS, and MKR BCN. These radio functions give azimuth, elevation angular deviation, and discrete position fixes relative to the runway threshold.

The following requirements are applicable to the VIDL:

- Gives VOR/LOC/GS/MKR functions including course deviation and glideslope deviation
- Meets ICAO FM immunity requirements
- Contains its own power supply so it can operate independent of the NIM.

- Gives NAV and MKR audio output to the NIM for digitization and transmission to the audio panels
- Supports tuning control by the MRC NIM
- Supports backup tuning control by way of ARINC 429
- Supports VOR/LOC receiver tuning over the frequency band 108.0 MHz to 117.95 MHz in 50 kHz increments
- Localizer receiver meets the requirements of RTCA DO-195
- VOR receiver meets the requirements of RTCA DO-196
- Supports glideslope receiver tuning over the frequency band 329.15 MHz to 335.0 MHz in 150 kHz increments
- Automatically tunes the glideslope receiver to the assigned frequency when the corresponding localizer frequency is tuned
- The glideslope receiver meets the requirements of RTCA DO-192
- Includes a marker receiver operating at 75 MHz
- Includes a MKR receiver capable of a HI/LO receiver sensitivity setting
- MKR receiver meets the requirements equipment intended for use in the European - Mediterranean area and wherever MKR signals are required for en route and approach operations
- Maintains a maintenance log stored in non-volatile memory
- Contains a built-in self-test functions which can be initiated as an IBIT test through the maintenance page of the CMC
- Supports growth to implement LAAS functionality
- Capable of operating with 18V minimum voltage.

Transponder (XPDR) XS-856A

The transponder is installed in the MRC 2 and another (option) can be located in the MRC 1. Each transponder gives conventional ATC functions.

The transponder module supports operation in Mode C, including a transponder ident function. The dual Mode S XPDR system enables secondary surveillance by transmission of aircraft identification information, altitude (barometric) and coded message data to air traffic control (ATC) ground stations, and TCAS installations on other aircraft. The XPDR supports Level 3 Com A, B, and C datalink capability and interfaces to an airborne datalink processor (ADLP). The XPDR supports basic downlink aircraft parameters. The NIM supplies barometric altitude data from the coupled side air data system (ADS) to the transponder module. The transponder has an ARINC 429 backup bus for tuning in case the NIM fails.

The flight ID information is given by the FMS, or it can be entered by the pilot. The XPDR receives the ICAO address programmed into the aircraft personality module (APM) and the pilot enters the squawk code.

The transponder module meets the requirements of the JAA Temporary Guidance Leaflet, Number 13 Revision 1, Certification of Mode S Transponder Systems for Elementary Surveillance.

The transponder system consists of the following equipment:

- One Mode S diversity transponder module in MRC 2
- Dual transponder antennas (top and bottom, diversity) per transponder module.

The ADLP interface supports the following:

- COM-A/B messages
- COM-C/D messages
- Altimeter interface
- TCAS interface.

NOTE: The SX-857A (option) Mode S diversity transponder module adds support for enhanced surveillance.

ENHANCED SURVEILLANCE REQUIREMENTS

For configurations requiring enhanced surveillance, one or two XS-857A transponder modules replace the XS-856A transponder module.

To support surveillance, the NIM gives additional Downlinks aircraft parameters to the XS-857A transponder module. The generic software in the NIM needs information to determine the coupled side AHRS and the coupled side ADS to the appropriate data can be transmitted for enhanced surveillance.

The NIM gives the ASCB parameters listed based on the source listed in Table 10-1.

The transponder module meets the requirements of JAA NPA 20-12a Certification of Mode S Transponder Systems for Enhanced surveillance.

Table 10-1
Downlink Aircraft Parameters

Parameter	Source
Magnetic heading	Coupled side AHRS
Indicated air speed	Coupled side ADS
Mach number	Coupled side ADS
Barometric altitude rate	Coupled side ADS
Inertial vertical velocity	Coupled side AHRS
Roll angle	Coupled side AHRS
True track angle	Priority FMS
Ground speed	Priority FMS
Track angle rate	Coupled side AHRS
True air speed	Coupled side ADS
MCP/FCU selected altitude	Priority CIOCAL
FMS selected altitude	Priority FMS
Barometric pressure setting	Coupled side ADS

Automatic Direction Finder (ADF)

The ADF module enables en route and terminal navigation and area guidance. It operates over the frequency band from 100.0 kHz to 1799.5 kHz in 500 Hz increments in normal operation. The ADF system can receive in the frequency band of 2181 kHz to 2183 kHz for maritime emergency listening and it can tune frequencies in the range from 190 kHz down to 100 kHz. The ADF has two selectable bandwidths.

A narrow band mode is used to reduce noise during navigation. A wide band mode is used to improve clarity when listening to voice signals. The optimal VOICE and bearing reception are under the following modes:

- Antenna (ANT): Receives ADF station signal and does not compute bearing
- ADF: Receives ADF station signal and computes relative bearing to station

- Voice: Opens IF bandwidth for improved audio fidelity and does not compute bearing
- Beat frequency oscillator (BFO): Adds a beat frequency oscillator for reception of CW signals.

The ADF interfaces to the display system through the ASCB-D bus by way of the cabinet internal RCB buses. ADF audio is transmitted from the digital audio bus to each audio panel in the system.

The ADF receiver interfaces to a dedicated active antenna that contains a pair of H-field loop antennas, balanced modulators, and summing preamplifiers for bearing information reception. The antenna contains an E-field element for AM signal reception and a self-test oscillator which, when activated, injects a signal into the antenna to test the entire ADF system.

The ADF receiver interfaces to a dedicated active antenna and its function is contained in the MRC. It includes:

- One ADF module (second is optional)
- One ADF antenna (second is optional).

The ADF module has the following features:

- The high frequency (HF) keying input prevents interference when HF is transmitting. When the HF is keyed, the ADF needle freezes for 10 seconds and is driven to the 3 o'clock park position where it disappears.
- The ADF interfaces to the display system through the ASCB-D bus by the radio backplane and NIM. ADF audio is transmitted from the digital audio bus to each audio panel in the system.

The following requirements are applicable to the ADF module:

- The module has its own power supply, permitting independent application of aircraft power to the module
- Maintains a maintenance log stored in non-volatile memory
- Supports tuning by the NIM over the frequency range of 100 kHz to 1799.5 kHz
- Gives maritime 2181 kHz to 2183 kHz emergency frequencies (0.5 kHz tuning increments), when enabled within the APM.

Distance Measuring Equipment (DME)

The baseline Agusta installation is a single DME system. The DME system enables en route and terminal navigation and area guidance. It operates over the frequency band from 960.0 MHz to 1215.0 MHz in 1 MHz increments and has six channels. The DME can track four channels to give the following:

- Slant range
- Ground speed
- Time to station (TTS)
- Station identification.

Two additional channels track station identification of preset channels for rapid acquisition. Frequency tuning is automatically paired with VHF NAV. The DME can operate in the HOLD mode, in which case, the frequency is not automatically paired with VHF NAV. When the FMS is active, two DME channels are dedicated to the FMS for distance, TTS, identification, and control. Another two channels are DME IDENT preset channels and two channels for flight crew control and distance, TTS, and IDENT display.

The DME system consists of the following equipment:

- One DME module (second is an option)
- One DME antenna (second is an option).

The DME interfaces with the display system and flight management system (FMS) through the ASCB-D bus.

The DME module has the following features:

- Accuracy to 0.05 NM $\pm$0.01% or range. At maximum range of 300 NM the error is no greater than $\pm$0.35 NM (2127 ft). At 20 NM, the approximate beginning of an approach, the error is a maximum of $\pm$0.07 NM ($\pm$425 ft).
- Digital audio IDENT transmission to audio panels.
- IDENT decoding of audio Morse code for alpha display.
- It has its own power supply permitting independent application of aircraft power to the module.

MULTIFUNCTION CONTROL DISPLAY UNIT (MCDU) RADIO CONTROL AND DISPLAY

The MCDU is the primary radio controller. The PFD and CCD can give quick and convenient access to change configured COM and NAV frequencies.

The MCDU, shown in Figure 10-3, is used to control all communications, navigation, and transponders in the system. The face of an MCDU is shown in Figure 10-3. To access the radio system, push the **RADIO** button.

Figure 10-3
Multifunction Control Display Unit

The MCDU faceplate includes nine function keys, 12 line select keys adjacent to the display, a dual concentric knob and an alphanumeric keypad. The MCDU controls the following systems and parameters:

- FMS
- Radio tuning
- TAWS control

- Timer control
- System test
- Power-up default = FMS.

NOTE: The FMS can tune the radios. For detailed FMS operation, refer to the applicable FMS operating procedures. Radio frequencies can be displayed on each PFD and controlled using the on-side CCD.

Radio frequences are displayed along the bottom edge of both PFD displays, as shown in Figure 10-4. The radio frequencies are accessed and changed by selecting the PFD with the CCD, as described in Section 5, Primary Flight Display (PFD), of this guide. Select the radio to be adjusted with the joystick on the CCD. Adjust the frequency using the stacked concentric knobs on the CCD. Radios displayed on the PFD are configured on the radio setup pages in either MCDU.

Figure 10-4
PFD Radio Tuning Boxes

Any of the components of the radio system that are not supplying valid data to the MCDU or PFD (the frequencies or operating commands associated with that function), are removed from the associated display and replaced with dashes.

MCDU Operation

The MCDU is the primary controller for the radio system. It uses line select buttons adjacent to the display to simplify its operation. Any selectable parameter, such as a VOR frequency can be changed. Push the corresponding line select button to place the cursor box around the desired parameter on the display. Rotate the dual concentric tuning knobs to change the boxed parameter value or load a new value directly from the keypad.

The MCDU has a menu paging system with edge control buttons. The sections are used to identify and control both the frequency and operating mode of the radio functions.

Panel Controls

The MCDU I panel and button function groups are shown in Figure 10-5.

Figure 10-5
MCDU I Control Groups and Display

- **Function Buttons** - Function buttons are used to control functions and they are located in area C. They include the following:
  - **PERF** - Selects access to the **performance** main menu
  - **NAV** - Selects the **navigation** main menu
  - **PREV** - Permits the user to move backward through the **previous** pages of a multipage menu structure
  - **FPL** - Selects the **flight planning** main menu

— **PROG** – Selects the **progress** main menu

— **DIR** – Selects the **direct to** main menu

— **BRT**/**DIM** – Pushing the **BRT** or **DIM** rocker button increases or decreases display screen brightness

— **MENU** – Selects the **main menu** for access to additional control pages

— **NEXT** – Permits the user to move forward through the next pages of a multipage menu structure

— **RADIO** – Displays the initial **radio** control page

— **DLK** – Activation of the **DLK** function key accesses the communication management function (CMF) pages for datalink functionality. An advisory message DLK NOT INSTALLED is displayed in the MCDU II scratchpad when the DLK function key is activated and CMF is not installed.

- **Keys** – Keys are used to enter data. The alpha (area A) and numeric (area N) keypads have keys. The display pages use line select buttons, left side (area L) and right side (area R).

- **Concentric Knobs** – Known as tune or tuning knobs, they are used to change a data field on the display that is identified and enclosed by the cursor box. This can be digits or modes depending upon the data field. The high order digits are changed by the larger lower knob. The low order digits are changed by the smaller upper knob.

- **Alpha Keys** – The English alphabet letters A through Z are in alphabetical order.

- **DEL** –Deletes or clears an entire item identified by the cursor box. The annunciator *DELETE* is displayed in the scratchpad area. When data is present in the scratchpad when *DELETE* is displayed, it can be recovered by pushing the **CLR** button once.

- **CLR** – Clears or removes one character at a time, from right to left, in the scratchpad area. Hold it down for repeated character clearing.

- **Numeric Keys** – Numeric digits 0 through 9.

- **SP** – Generates a **space** character at the current location in the scratchpad area.

- • – The period is used to represent a decimal point in numerical inputs such as radio frequencies.

- **+/–** – The **plus/minus** key is used to insert a **–**, push again for a **+** character (alternate action button).
- / – The **slash** key is used to insert a slash character.

NOTE: The alpha and numeric keypad keys and the **CLR** button have a repeat function. When the button is held down, it is repeatedly entered into the data field.

Scratchpad Area

Data for radio tuning can be entered using the scratchpad area on the bottom line of the MCDU screen. Alpha/numeric data, after being typed directly into the scratchpad, can be transferred to a destination field. The field is identified by pushing one of the screen line select buttons. When the data is in a valid format for that field, the data is transferred. The valid format varies depending on where the data is transferred. When data is determined to be in an invalid format, the INVALID ENTRY is displayed in the scratchpad area of the MCDU. The INVALID ENTRY can be removed by pushing the **CLR** button on the MCDU panel. The original scratchpad data is returned to the scratchpad. The data in the scratchpad is cleared when it is transferred to another destination. Data can be removed from the scratchpad one character at a time from right to left by pushing the **CLR** button or holding it down to use the repeat CLR function. The **DEL** button clears the total scratchpad.

The scratchpad can accept more than 24 characters. After 24 characters are entered, all data is shifted to the left as new characters are entered.

Line Select Keys

Line select keys are used to operate the MCDU menu items. The first push of a line select button moves the cursor to surround the data field associated with that button. It transfers the contents of the scratchpad when the data is valid for selected radio. The cursor connects that data field to the TUNING knobs so the digits or modes can be changed. For some functions, pushing the line select key toggles modes or recalls stored frequencies. Figure 10–6 shows the line select button layout and identifiers that are used in this guide.

Figure 10-6
MCDU Display and Line Select Button Layout

MCDU Display

The MCDU radio tuning pages control frequencies, memory selections, operating modes, and options. Color is used with two font sizes. The active choice is shown in the larger font and in a color other than white. Display pages are normally white. Selections are in larger green **characters** and annunciators can be in green, amber, or red.

In normal use, the line select button adjacent to the displayed function executes the function described by the prompt. The top line is the page header and includes the number of pages in the group. Example 1/2 is the first page of a total of two pages, the second page is 2/2.

The scratchpad is used to enter data from the keypads. For example, the pilot enters **124.45** using the keypad. The scratchpad shows **124.45**. When the pilot tries to transfer the frequency to a NAV radio, the frequency is replaced with **Invalid data** annunciator in the scratchpad (such as, 124.45 is not a valid NAV frequency). Pushing the **CLR** button deletes the **Invalid data** annunciator and restores **124.45** to the scratchpad. When the pilot transfers **124.45** to a VHF COM radio, the frequency is valid, the transfer is made and the scratchpad is cleared.

DISPLAY CURSOR

The cursor is a white box that encloses the data field that is selected by pushing the associated line select button. The cursor has a default position when the page is first opened. The cursor in the COM or NAV radio area encloses the Active, Standby, or Memory frequency fields. The memory selections are available on the detail pages. The cursor defaults to the standby frequency in the radio pages and to the memory frequency on the detail pages.

DISPLAY PROMPTS/ICONS

Control prompts help the pilot navigate through the pages. They indicate what action is required. They give some indication of the expected result once the prompt is activated. The prompts are located in the display columns immediately next to the line select buttons. The prompts are white, as shown in Figure 10-7.

Figure 10-7
Examples of Display Prompts

When the scratchpad is empty, pushing a line select key moves the format cursor to the adjacent field, or performs the function indicated by the icon that appears near the key. The icons and their functions are described in the following paragraphs.

- **Swap Frequencies** – This symbol indicates exchanges between the active and preset frequencies for the associated radio that can be made. This effectively saves the currently active frequency in the preset memory and tunes the radio to the frequency previously stored as the preset.


ID-099655

- **Page Indicator** – When this icon is displayed, pushing the adjacent line select key (LSK) changes the display to another page. The page to be displayed is labeled explicitly or it is a detail page for the radio in the associated field.


ID-099656

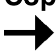
- **Exclusive Selection** – This icon is displayed next to a list of mutually exclusive options. Each time the adjacent LSK is pushed, the next item in the list is selected, wrapping around to the first when the last option is reached. The selected value is displayed in green **large** font. The unselected items are displayed in **small** white characters.


ID-099657

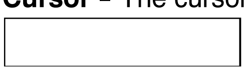
- **Immediate Function** – This icon indicates the function identified in the field executed immediately after the associated LSK key is pushed.


ID-099658

- **Copy Value** – This icon is used on the memory pages to indicate that the frequency highlighted by the cursor is copied into the active frequency for the associated radio.


ID-099659

- **Cursor** – The cursor box highlights the value in the active field.


ID-099660

- **Tuning Curl** – This icon indicates that the data value highlighted by the format cursor can be changed by turning the MCDU tuning knob.


ID-099661

FREQUENCY SWAPPING OPERATION

Three types of radio frequencies can be displayed.

- **Active** frequency is the one that the radio is currently set to for receiving or transmitting.
- **Standby** frequency is the one waiting to be used next. The Standby frequency can be changed using the tuning knobs or the scratchpad.

- **Memory** frequency is the one with a list of frequencies that is stored for recall.

Two swap functions are used. The first one uses the standby frequency. The second one uses the memory frequency.

- With the cursor around the standby frequency and the swap icon displayed when the line select key is pushed, the standby and active frequencies are switched.

NOTE: Expect a short delay for the display change to take place.

- With the cursor around the Memory frequency and the swap icon displayed when the line select key is pushed, the Memory and Active frequencies are switched.

To make the standby frequency active, push the 4L button next to the active COM frequency. This swaps the Standby and Active frequencies, as shown in Figure 10-8.

VHF COM and HF COM radio pages use Active, Standby, and Memory frequencies. They do not permit the use of the tuning knobs to change the Active frequency.

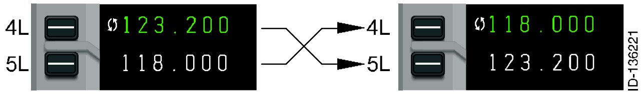


Figure 10-8
Swapping the Active and Standby Frequencies

Page Organization

The radio tuning function is accessed by pushing the **RADIO** function button on the MCDU. That shows the RADIO 1/2 page. All other pages are accessed from the RADIO 1/2 page using the LSK or the **NEXT** and **PREV** function buttons, shown in Figure 10-9.

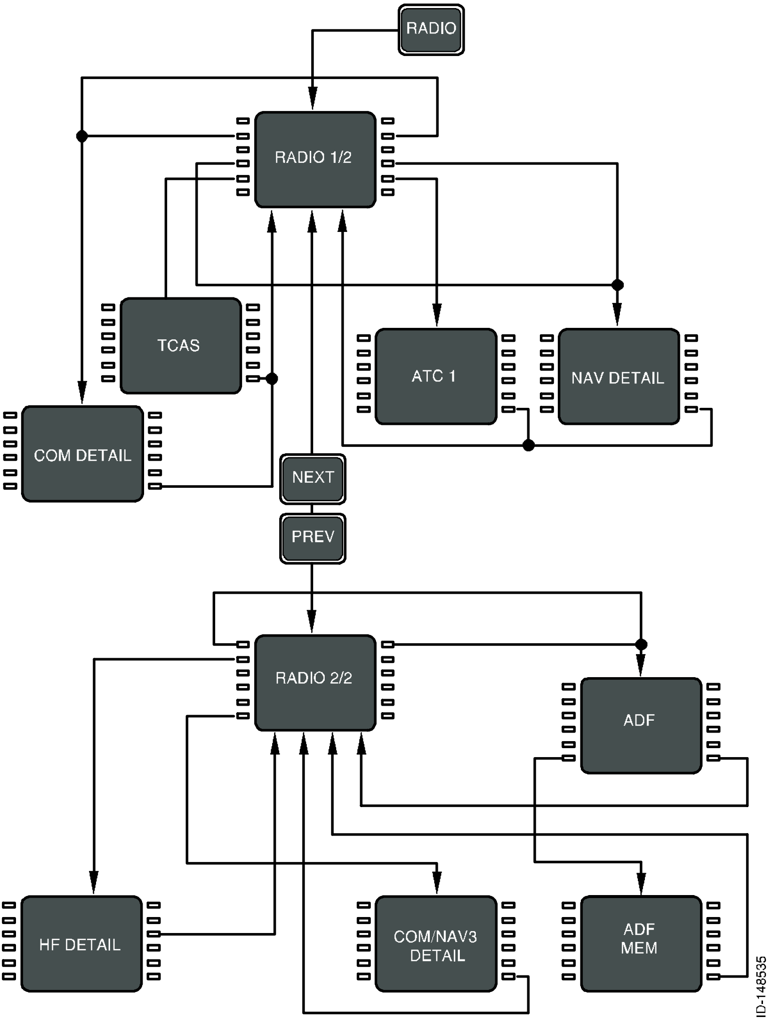


Figure 10-9
Radio Tuning Logic Diagram

Access to the COM DETAIL, TCAS, and NAV DETAIL pages is by the LSK from the RADIO 1/2 page. Access the HF DETAIL and ADF DETAIL pages by the line select keys from the RADIO 2/2 page.

BASIC OPERATION

The bottom line on each page shows the characters entered on the MCDU keypad and is called the scratchpad. The scratchpad is shared across all MCDU functions and is not under the control of the radio tuning function.

The text area adjacent to each LSK on the MCDU is referred to as a field, and identified by the LSK it is associated with. For example, the active frequency for VHF COM radio 1 (shown as COM1, 123.200 in Figure 10-10) on the RADIO 1/2 page is in field 1L.

Figure 10-10
MCDU Button Locations

Pushing the **NEXT** or **PREV** button when this page is displayed, shows the RADIO menu page 2/2, as shown in Figure 10-11.

Figure 10-11
NEXT/PREV Example

When an icon is displayed next to a line select key, the function denoted by the icon takes precedence over moving the format cursor. For example, pushing LSK 1L exchanges the active and preset frequencies for VHF COM1 radio without moving the format cursor, as shown in Figure 10-12. Consequently, it is not possible to tune the active frequency for a radio using the tuning knob.

Figure 10-12
Cursor Example

The exception to this rule is the case where a preset frequency is not shown for the associated radio. When a VHF navigation radio is in DME HOLD, which results in the preset frequency is removed to show the separately tuned DME frequency (refer to fields 3L and 4L).

When one or more characters are present in the scratchpad, the icons adjacent to fields that accept text entries are removed to indicate that pushing those LSKs enters the scratchpad data into the field. Entering the contents of the scratchpad into a field, or manually clearing the scratchpad, restores the icons and the normal functions of the line select keys.

Scratchpad entries can be made into any editable field at any time. Making a scratchpad entry into an active frequency field moves the previously active frequency into the preset field for that radio.

MENU PAGES

MENU 1/2 Page

Activation of the **MENU** button or the **PREV/NEXT** buttons on the Menu page one or two, gives access to all MAU generated subpages. Shown in Figure 10-13, the MAU generated subpages (TAWS and TEST) are available on LSK 1L and 1R respectively and give additional menus for selection.

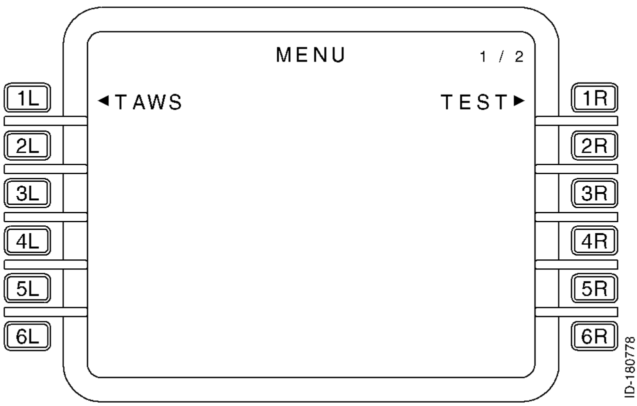


Figure 10-13
MENU 1/2 Page

TAWS PAGE

The layout of the TAWS page is shown in Figure 10-14. The pilot and copilot TAWS pages are synchronized and the selections made on either MCDU processed on the last entered basis.

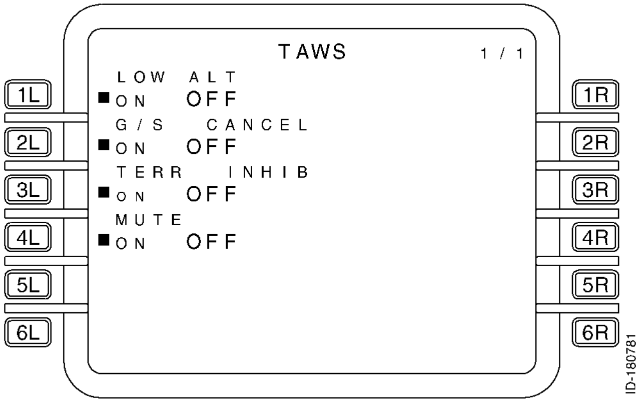


Figure 10-14
TAWS Page

The normal state of each of these selections is the OFF state. A status CAS message is given to alert the pilot when any of these selections are set to ON.

- **Low Alt** - Alternate activation of the LSK adjacent to this selection toggles the status of the TAWS low altitude mode between ON and OFF. The active condition is highlighted in larger font. Power-up default = OFF.

- **G/S CANCEL**- Alternate activation of the LSK adjacent to this selection toggles the status of the below glideslope warning cancellation between ON and OFF. The active condition is highlighted in larger font. Power-up default = OFF.

- **TERR INHIB** - Alternate activation of the LSK adjacent to this selection toggles the status of the terrain inhibited from display between ON and OFF. The active condition is highlighted in larger font. Power-up default = OFF.

- **MUTE** - Alternate activation of the LSK adjacent to this selection toggles the status of active TAWS aural warnings between ON and OFF. The active condition is highlighted in larger font. Power-up default = OFF.

TEST PAGE

The layout of the TEST page is shown in Figure 10-15. The self-test function of each subsystem is activated by selecting the correct LSK adjacent to the desired system to be tested.

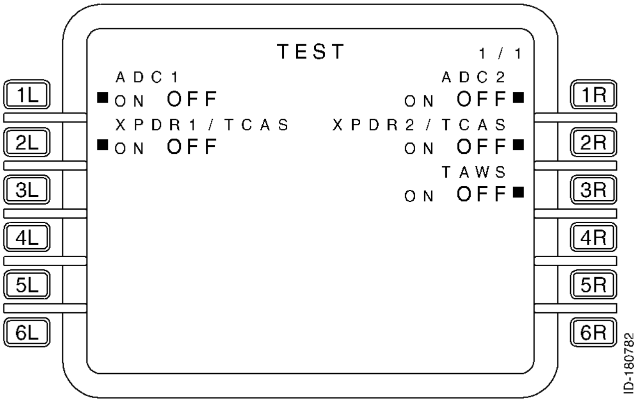


Figure 10-15
TEST Page

The active state is highlighted in larger font. The air data function test is active for as long as the LSK is pushed. When the transponder test is activated, the TCAS is placed into test.

Selection of the LSS key to ON has the clear/test discrete set to GROUND for 120 seconds or until the pilot selects the LSS test to OFF.

The test page selection is synchronized between the pilot or copilot MCDU with the selections made on either MCDU processed on a last entered basis. Display of each of the potential test LRU on the TEST page is enabled using the APM parameters that indicate the LRU is installed.

MENU 2/2 Page

Activation of the **PREV**/**NEXT** buttons give access to Menu page 2/2 which shows all of the compliant systems. Each system is listed next to an individual LSK. The MAU is the compliant system on the AW139/AB139 aircraft. This is identified as the MENU 1/2 prompt on the MENU page 2/2. The MCDU has been configured to use one of the A739 ports to perform backup radio tuning. MCDU radio tuning is accessed from the MENU page 2/2, as shown in Figure 10-16.

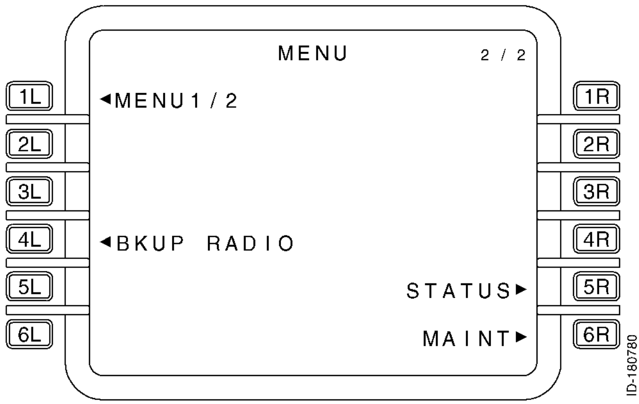


Figure 10-16
MENU 2/2 Page

PRIMARY MCDU RADIO TUNING

All of the radios can be tuned by way of the two top level radio menu pages. They are annunciated on the MCDU as 1/2 and 2/2 at the top right corner of the MCDU display. Radios HF, HF2, ADF1 and ADF2 are located on DETAIL page 2/2.

RADIO 1/2 Page

RADIO 1/2 page, as shown in Figure 10-17, is displayed by pushing the RADIO function key on the MCDU. It contains the following radio data:

- VHF COM1 and COM2 radios
- VHF NAV1 and NAV2 radios
- The currently selected TCAS/transponder mode
- The aircraft ID (identification) (if available)
- The current transponder code and status.

To toggle between RADIO 1/2 and RADIO 2/2, use the **NEXT** or **PREV** buttons.

ID-148539

Figure 10-17
RADIO 1/2 Page

When the **RADIO** button is pushed, the tuning box defaults to the preset COM1 frequency.

When the PAST is initiated for one of the COM or NAV radios, the test status is shown instead of the current and preset frequencies. The status display shows **TEST** when the test is running and **PASS** or **FAIL** depending on the test result. The test result is shown for five seconds after the test stops.

The RADIO page 1/2 shows **XPDR** when one transponder is installed. When two transponders are installed, the annunciator **XPDR1** or **XPDR2** is displayed according to the transponder selected from the transponder detailed page.

The RADIO page 1/2 permits control of the current transponder code by toggling between standby, the current transponder mode, and initiation of the IDENT function.

- **1L VHF COM1 Active Frequency** – Pushing 1L exchanges the active and preset frequencies for VHF COM1. A scratchpad entry into the field replaces the preset frequency with the previously active frequency.
- **2L VHF COM1 Preset Frequency** – This is the default field for the format cursor when the **RADIO** button is pushed. Pushing the button when the format cursor is already in the field shows the COM1 detail page.
- **3L VHF NAV1 Active Frequency** – When DME HOLD for NAV1 is OFF, pushing 3L exchanges the active and preset frequencies for VHF NAV1. When DME HOLD for NAV1 is ON, pushing 3L moves the cursor to field 3L or shows the NAV1 page when the cursor is already in the field. A scratchpad entry into 3L replaces the preset frequency with the previous active frequency.
- **4L VHF NAV1 Preset Frequency** – When DME HOLD for NAV1 is OFF, this section shows the VHF NAV1 preset frequency. When DME HOLD is ON, this section shows the active DME frequency for NAV1. The format cursor can be used in field 4L. When the 4L is pushed when the cursor is in the field, the NAV1 detail page is displayed.
- **5L TCAS/XPDR** – Pushing this key shows the TCAS/XPDR 2/2 page.
- **6L STBY TA/RA** – Pushing this line key alternately selects STBY or the selected mode as the active mode. The active condition is green, the inactive annunciator is white.
- **1R VHF COM2 Active Frequency** – Pushing 1R exchanges the active and preset frequencies for VHF COM2. A scratchpad entry into the field replaces the preset frequency with the previously active frequency.
- **2R VHF COM2 Preset Frequency** – Pushing 2R when the format cursor is already in the field shows the COM2 detail page.
- **3R VHF NAV2 Active Frequency** – Pushing LSK 3R when DME HOLD for NAV2 is OFF, exchanges the active and preset frequencies for VHF NAV2. Pushing LSK 3R when DME HOLD for NAV2 is ON moves the format cursor to field 3R or shows the NAV2 page when the cursor is in the field. A scratchpad entry into 3R replaces the preset frequency with the previous active frequency.
- **4R VHF NAV2 Preset Frequency** – When DME HOLD for NAV2 is OFF, the VHF NAV2 preset frequency is displayed. When DME HOLD is ON, the active DME frequency for NAV2 is displayed. The format cursor is given in field 4R. Pushing 4R when the format cursor is in the field shows the NAV2 page.

- **5R Active Transponder Code and Reply Indicator** – This section shows the active transponder code and reply indicator. The header for field 5R shows the flight ID, when it is available or is entered by the crew. The reply indicator ( ) lights when the transponder is replying to a RADAR or TCAS interrogation. Pushing 5R moves the format cursor to the field or shows TCAS1/1 when the cursor is in the field.

- **6R** – To transmit an IDENT reply when requested by ATC, push the line select button at 6R next to the IDENT label.

RADIO 1/2 ANNUNCIATORS

Table 10–2 describes the annunciators on RADIO 1/2.

Table 10–2
RADIO 1/2 Annunciator Descriptions

Annunciator	Description
25K	Indicates that the associated VHF COM radio is set to 25 kHz frequency spacing. When not present, the radio is tuning with 8.33 kHz frequency spacing. This is selected on the COM 1/2 page.
DME H xxx	This alert indicates that the VHF navigation radio is tuning the corresponding DME receiver independently of the primary navigation frequency.
IHBT	This annunciator indicates that tuning of the radio is inhibited, usually from a remote source (such as an emergency tuning function).
MICSTK	Indicates that the microphone button on the radio has been down long enough that the radio has identified it as stuck in the transmit position.
SQ	This annunciator indicates that the squelch feature for the radio is active. Squelch is set turned ON and OFF by the COM 1/2 page.
TX	This annunciator indicates that the radio is currently transmitting.

RADIO 2/2 Page

RADIO 2/2, as shown in Figure 10-18, is described in the following paragraphs and shows the following radio data:

- HF1 and HF2 radios
- ADF1 and ADF2 radios
- NAV/COM3 radios.

Access to RADIO 1/2 is by the NEXT or PREV buttons.

Figure 10-18
RADIO 2/2 Page

The baseline configuration supports display of ADF2 information on the RADIO tuning page 2/2. Display of ADF1, HF1 and HF2 radio controls are enabled by way of an APM parameter. The places reserved for ADF1, HF1, HF2 and NAV/COM3 are blanked in the baseline configuration.

- **1L Active ADF Frequency** - This section is the ADF 1 active frequency. Pushing 1L exchanges the active and preset frequencies for the ADF. A scratchpad entry into the field replaces the preset frequency with the previously active frequency.

- **2L Preset ADF Frequency** – This section is the ADF 1 preset frequency. Pushing 2L when the format cursor is already in the field shows the ADF 1/1 page.

- **3L Active HF COM1** – This section is the HF COM1 active frequency. Pushing 4L exchanges the active and preset frequencies for HF COM1. A scratchpad entry into the field replaces the preset frequency with the previously active frequency.

- **4L Preset HF COM1** – This section is the HF COM1 preset frequency. It is the default field for the format cursor when the RADIO 2/2 page is displayed. Pushing 4L when the cursor is already in the field shows the HF1 page.

- **5L Active COM3, NAV3, COM/NAV3** – This is the active COM3, NAV3, or COM/NAV3 frequency. Pushing 5L exchanges the active and preset frequencies for the installed radio. A scratchpad entry into the field replaces the preset frequency with the previously active frequency.

- **6L Preset COM3, NAV3, COM/NAV3** – This section is the COM3, NAV3, or COM/NAV3 preset frequency. Pushing 6L when the format cursor is already in the field shows the detail page for the installed radio.

- **1R Active ADF2 Frequency** – This is the ADF2 active frequency. Pushing 1R exchanges the active and preset frequencies for the ADF. A scratchpad entry into the field replaces the preset frequency with the previously active frequency.

- **2R Preset ADF2 Frequency** – This is the ADF2 preset frequency. Pushing 2R when the format cursor is already in the field shows the ADF2 page.

- **3R Active HF COM2** – This section is the HF COM2 active frequency. Pushing 3R exchanges the active and preset frequencies for HF COM2. A scratchpad entry into the field replaces the preset frequency with the previously active frequency.

- **4R Preset HF COM2** – This section is the HF COM2 preset frequency. It is the default field for the format cursor when the RADIO 2/2 page is displayed. Pushing 4R when the cursor is already in the field shows the HF COM2 page.

RADIO 2/2 ANNUNCIATORS

A variety of annunciators appear on the radio tuning pages and some are shown in Figure 10-19.

Figure 10-19
RADIO 2/2 Annunciators

Table 10-3 lists the annunciators on RADIO 2/2 page.

Table 10-3
RADIO 2/2 Annunciator Descriptions

ALERT	DESCRIPTION
ANT	The ADF radio is in antenna mode.
BFO	The ADF radio is operating in BFO mode.
CW	This annunciator indicates that the radio is in a continuous wave mode.
IHBT	Indicates that tuning of the radio is inhibited, usually from a remote source (such as an emergency tuning function). Transmitting and/or receiving can be inhibited periodically when the other HF radio has recently performed a transmit operation.
ITU	This annunciator indicates that the radio frequency is an ITU frequency.
LO	The radio is set to low squelch.
MED	The radio is set to medium squelch.
RX	Indicates that the radio is currently receiving.
SQ	This annunciator indicates that the squelch feature for the radio is active.
TX	This annunciator indicates that the radio is currently transmitting.
TX MIN	The radio is transmitting with low power.
TX MED	The radio is transmitting with medium power.
VOICE	The ADF radio is in voice mode.

COM1 Page

The pages associated with VHF COM radios are shown in Figure 10-20.

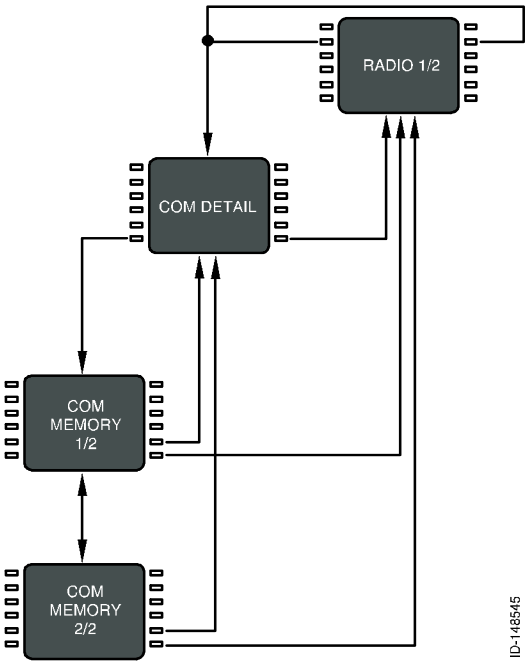


Figure 10-20
VHF COM Radio Tuning Logic Diagram

The COM1 detail page, as shown in Figure 10-21, is described in the following paragraphs. The COM detail page is accessed by selecting the line key associated with the adjacent preselect boxed frequency in the main MCDU Radio page 1/2. It is used to access the controls specific to VHF communications radios, including squelch, operating mode, frequency spacing and a quick method for retrieving 12 frequencies from memory.

The COM detail page provides a means to start or stop a PAST. The status display shows **TEST** when the test is running and **PASS** or **FAIL** depending on the test result. The test result is shown for five seconds after the test stops. The COM radio PAST and status display is terminated upon exit from the COM detail page.

The format cursor defaults to the memory tuning field (3L), giving a quick access to stored frequencies. The page gives access to the COM memory pages. Pushing the RADIO 1/2 LSK supplies a method of returning to the main radio Radio 1/2 page. The COM detail page permits selection of 8.33 kHz or 25 kHz COM tuning.

Figure 10-21
COM1 Page

- **1L Active VHF COM Frequency** – The active VHF COM frequency on the selected radio reflects which COM radio is selected. Pushing 1L exchanges the active and preset frequencies (when the format cursor is on field 2L), or copies a frequency stored in memory (when the format cursor is on field 3L) for the selected COM radio. A scratchpad entry into the field replaces the preset frequency with the previously active frequency.

- **2L Preset VHF COM Frequency** – This section shows the VHF COM preset frequency.

- **3L MEM TUNE** – This section is the COM memory display. This is the default field for the format cursor when the COM1 or COM 2 pages are displayed. Turning the tuning knob when field 3L is selected cycles through the frequencies stored in memory, by location, showing the associated label and the stored frequency below.

- **6L MEMORY** – Pushing this key shows the COM MEMORY 1/2 page.

- **1R SQUELCH** – This key toggles the squelch feature for the selected VHF COM radio ON and OFF. The **selected** state is green.

- **3R FREQ** – This key toggles the frequency spacing selection for the selected VHF COM radio between 8.33 kHz and 25 kHz. The **selected** spacing is green.

- **6R RETURN** – Pushing this key shows the RADIO 1/2 page.

COM MEMORY 1/2 AND 2/2 PAGES

Selecting the line key MEMORY in the COM 1/1 pages shows the COM memory detail page COM 1/2.

The radio tuning function supports 12 memories per radio type (such as, COM, NAV, HF COM, etc.) displayed on two pages. The controls given on the COM memory page include access to the remaining six memory locations (7–12) by pushing the **NEXT** button.

The COM memory page includes a quick method of returning to the COM detail page by selecting the COM x line key or to the main radio page by selecting the RADIO 1/2 line key. Both of these keys are located on the bottom right side of the COM memory page.

In addition to entering or dialing-in frequencies for each memory, a text label of up to eight characters can be entered for each stored frequency, as shown in Figure 10-22 (except for the HF COM memory page, which does not support labels due to display area limitations). The default label for each memory is MEMORY, a dash, and the memory number, with the memory number always on the outboard edge of the display.

Figure 10-22
COM MEMORY 1/2 Page

- **1L Active VHF COM Frequency** - Active VHF COM frequency is displayed in green, and the selected radio title is white. Pushing 1L copies the field containing the cursor into the active frequency and moves the previously active frequency into the preset field (not shown on this page). A scratchpad entry into the field replaces the preset frequency with the previously active frequency.

- **2L, 3L, 4L** - These are the VHF COM1 memories 1-3.

- **2R, 3R, 4R** - These are the VHF COM1 memories 4-6.

- **5R COM1** – Pushing this LSK shows the COM1 detail page.
- **6R RADIO 1/2** – Pushing this LSK shows the RADIO 1/2 page.

Labels are entered by typing into the scratchpad and pushing the line select key adjacent to the desired frequency. When the radio tuning function determines that the entry is a valid frequency for the radio, the entry is accepted into the frequency field. If not, the entry is considered a label and is entered into the label field above the frequency. A label can be replaced by making another scratchpad entry into a memory field, or by pushing the **DEL** key. Pushing the **DEL** key places the text DELETE in the scratchpad, and when entered on a memory field deletes the associated text label returning it to the default. When the **DEL** key is used on a memory where there is no user-entered label, the frequency is deleted from memory.

The COM MEMORY 2/2, as shown in Figure 10-23, is described in the following paragraphs. It is accessed by the **NEXT** and **PREV** buttons. It operates identically to the COM MEMORY 1/2 page.

Figure 10-23
COM MEMORY 2/2 Page

- **1L Active COM1 Frequency** – The active VHF COM frequency is displayed in green, and the selected radio title is white. Pushing 1L copies the field containing the cursor into the active frequency and moves the previously active frequency into the preset field. A scratchpad entry into the field replaces the preset frequency with the previously active frequency.

- **2L, 3L, 4L** – VHF COM memories 7–9.

- **2R, 3R, 4R** – VHF COM memories 10–12.

- **5R COM1** – Pushing this key shows the COM1 detail page.

- **6R RADIO 1/2** – Pushing this key shows the RADIO 1/2 page.

NAV1 Page

The pages associated with VHF NAV radios are shown in Figure 10–24.

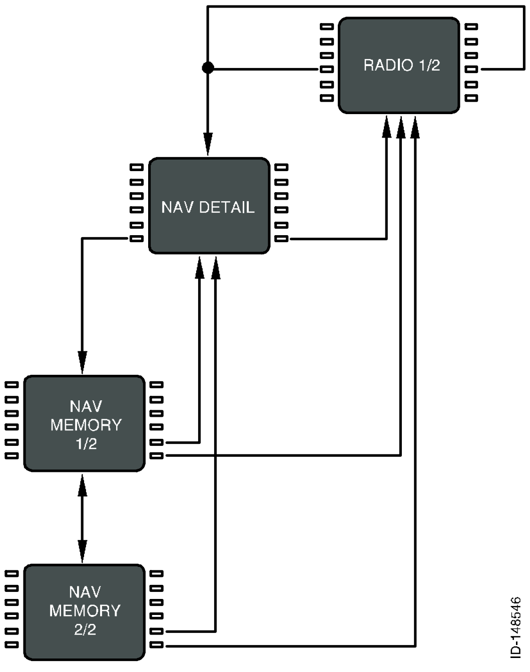


Figure 10–24
VHF NAV Radio Tuning Logic Diagram

The NAV1 page, as shown in Figure 10-25, is described in the following paragraphs. It is used to access and control VHF navigation radios, FMS automatic tuning, and DME hold mode. The format cursor defaults to the memory tuning field (4L) giving quick access to stored frequencies. The page can access the NAV memory pages and permit the FMS auto tuning to be turned ON and OFF. In addition, the NAV detail page gives marker HI/LO sensitivity settings.

The NAV detail page gives a means to start or stop a PAST. The status display shows **TEST** when the test is running and **PASS** or **FAIL** depending on the test result. The test result is shown for five seconds after the test stops. The NAV radio PAST and status display is terminated upon exit from the NAV detail page.

Figure 10-25
NAV1 Page

- **1L Active VHF NAV Frequency** - The **active** VHF NAV frequency is displayed in green. The white page title shows the NAV radio that was selected. Pushing 1L exchanges the active and preset frequencies (when the cursor is on field 2L) or copies a

frequency stored in memory (when the cursor is on field 4L). A scratchpad entry into the field replaces the preset frequency with the previously active frequency.

- **2L Preset VHF NAV Frequency** – This section is the VHF NAV preset frequency.

- **3L DME Frequency** – This section is the active DME frequency. This field is displayed when the DME hold mode is enabled, otherwise DME tuning is slaved to the corresponding VHF NAV radio frequency.

- **4L MEM TUNE** – This section is the NAV memory display. This is the default field for the format cursor when the NAV1 or NAV2 pages are displayed. Turning the tuning knob while field 4L is selected cycles through the frequencies stored in memory by location, showing the associated label and the stored frequency below.

- **6L MEMORY 1/2** – Pushing this key shows the NAV MEMORY 1/2 page.

- **1R AUTOTUNE** – Pushing this key toggles the FMS autotune feature ON and OFF for the selected VHF NAV radio. The selected state is green. The selected state is annunciated on the RADIO 1/2 page.

- **2R DME HOLD** – Pushing this key toggles the DME hold mode ON and OFF for the selected VHF NAV radio. The selected state is green. The selected state is annunciated on the RADIO 1/2 page.

- **3R MKR SENS** – Pushing this key toggles the marker sensor between HI and LO values. The selected state is green. The marker sensitivity state is annunciated on the RADIO 1/1 page.

- **6R RETURN** – Pushing this key shows the RADIO 1/2 page.

NAV MEMORY 1/2 AND 2/2 PAGES

The radio tuning function supports 12 navigation radio memories displayed on two pages. In addition to entering or dialing-in frequencies for each memory, a text label of up to eight characters can be entered for each stored frequency. The default label for each memory is **MEMORY**, a dash, and the memory number, with the memory number always on the outboard edge of the display, as described in the following paragraphs. The MEMORY 1/2 page is shown in Figure 10-26.

Figure 10-26
NAV MEMORY 1/2 Page

- **1L Active NAV COM Frequency** – The active NAV COM frequency on the selected radio is displayed in green. The white field title shows the NAV radio that was selected. Pushing 1L copies the field containing the cursor into the active frequency and moves the previously active frequency into the preset field. A scratchpad entry into the field replaces the preset frequency with the previously active frequency.
- **2L, 3L, 4L** – These locations store NAV memories 1-3.
- **2R, 3R, 4R** – These locations store NAV memories 4-6.
- **5R NAV1** – Pushing this key shows NAV detail page.
- **6R RADIO 1/2** – Pushing this key shows the RADIO 1/2 page.

Labels are entered by typing into the scratchpad and pushing the line select key adjacent to the desired frequency. When the radio tuning function determines that the entry is a valid frequency for that radio, the entry is accepted into the frequency field. When the frequency is not valid, the entry is considered a label and it is entered into the label field above the frequency. A label can be replaced by making another scratchpad entry into a memory field, or by pushing the **DEL** button. Pushing the **DEL** button places the text **DELETE** in the scratchpad and, when entered on a memory field, deletes the associated text label, returning it to the default. When the **DEL** button is used on a memory where there is no user-entered label, the frequency is deleted from memory.

The NAV MEMORY 2/2 page, shown in Figure 10-27, is described in the following paragraphs. It is accessed by the **NEXT** and **PREV** buttons.

Figure 10-27
NAV MEMORY 2/2 Page

- **1L Active NAV COM Frequency** – The active NAV COM frequency on the selected radio is displayed in green. The white field title shows the NAV radio that was selected. Pushing 1L copies the field containing the cursor into the active frequency and moves the previously active frequency into the preset field. A scratchpad entry into the field replaces the preset frequency with the previously active frequency.
- **2L, 3L, 4L** – These locations store NAV memories 7–9.
- **2R, 3R, 4R** – These locations store NAV memories 10–12.
- **5R NAV1** – Pushing this key shows the NAV detail page.
- **6R RADIO 1/2** – Pushing this key shows the RADIO 1/2 page.

COM3 Page (Option)

The COM3 page, as shown in Figure 10–28, is selected from the RADIO page 2/2. Select the **RADIO** button on the MCDU. Select the **NEXT** button to get to RADIO 2/2, then select the line select 6L twice to display this page.

Figure 10–28
COM3 Page

- **1L Active VHF COM Frequency** – Active VHF COM frequency on the selected radio is displayed in green and the page title shows the COM radio that was selected. Pushing 1L exchanges the active and preset frequencies (when the cursor is on field 2L), or copies a frequency stored in memory (when the cursor is on field 3L) for the selected COM radio. A scratchpad entry into the field replaces the preset frequency with the previously active frequency.

- **2L Preset VHF COM Frequency** – This section shows the VHF COM preset frequency.

- **3L MEM TUNE** – This section is the COM memory display. This is the default field for the cursor when the COM3 page is displayed. Turning the tuning knob when field 3L is selected, cycles through the frequencies stored in memory by location showing the associated label and the stored frequency below.

- **6L COM MEMORY** – Pushing this key shows the NAV MEMORY 1/2 page.

- **1R SQUELCH** – This key toggles the squelch feature for the selected VHF COM radio. The selected state is green. The selected state is displayed on the RADIO 2/2 page.

- **2R MODE** – This key toggles between voice and data mode for the selected VHF COM radio. The selected mode is green. The selected state is displayed on the RADIO 2/2 page.

- **3R FREQ** – This key toggles the frequency spacing selection for the selected VHF COM radio between 8.33 kHz and 25 kHz. The selected spacing is green. The selected state is displayed on the RADIO 2/2 page.

- **6R RETURN** – Pushing this key shows the RADIO 2/2 page.

TCAS/XPDR

The TCAS/XPDR 1/2 detail page, as shown in Figure 10–29, is described in the following paragraphs. The TCAS/XPDR 1/2 page is accessed by selecting the line key associated with the adjacent boxed transponder code in the RADIO 1/2 page.

Once the radio process has been initiated, continuous processing results regardless of whether the TCAS/XPDR 1/2 page is displayed or not. Once the TCAS/XPDR 1/2 page is displayed, active page processing starts.

Figure 10-29
TCAS Page

The XPDR detail page permits control of the active and preset transponder codes. Pressure altitude is transmitted by the active transponder. The XPDR detail page gives a quick method of returning to the main RADIO 1/2 page by selecting the RADIO 1/2 line select key. It permits viewing and sets the flight ID. In addition, it commands the transponder to transmit **IDENT**.

The XPDR detail page gives a means to start or stop a PAST. The status display shows **TEST** when the test is running and **PASS** or **FAIL** depending on the test result. The test result is shown for five seconds after the test stops. The XPDR radio PAST and status display is terminated upon exit from the XPDR detail page.

When transponders XPDR1 and XPDR2 are installed and enabled, the transponder detail page permits selection of the active transponder XPDR1 or XPDR2. When one transponder is installed and active, the transponder selection of XPDR1 or XPDR2 is removed from the display location.

TCAS/XPDR 2/2 PAGE

The TCAS/XPDR 2/2 page, as shown in Figure 10-30, is accessed by selecting the TCAS/XPDR line key on the RADIO page 1/2 to display the TCAS/XPDR 1/2 page and then selecting the **NEXT** button.

Figure 10-30
TCAS/XPDR Page

Once the radio process has been initiated, continuous processing results regardless of whether the TCAS/XPDR 2/2 page is displayed or not. Once the TCAS/XPDR 2/2 page is displayed, active page processing starts.

The transponder operating modes on the TCAS/XPDR 2/2 page are described in the following list:

- **TA/RA**: Traffic alert/resolution advisory
- **TA**: Traffic alert
- **ALT-ON**: Transponder MODE C operation
- **ALT-OFF**: Transponder MODE A operation.

NOTE: The selection for standby (STBY) is on the RADIO 1/2 page.

The TCAS/XPDR 2/2 page gives the ability to control the TCAS/XPDR operating mode. The following list describes the available operating modes when TCAS and transponders are installed.

- When TCAS II is installed, all four modes TA/RA, TA, ALT-ON and ALT-OFF are available.
- When TCAS I is installed, modes TA, ALT-ON, ALT-OFF are available.
- When one transponder is installed with no TCAS, modes ALT-ON and ALT-OFF are available.

High Frequency (HF) COM1

Figure 10-31 shows the sequence of screens that are associated with high frequency (HF) communication radios. The tuning and mode selection of the HF system is performed through the radio tuning pages on the MCDU. By initially selecting the **RADIO** button on the MCDU, the display shows the initial MCDU RADIO page 1/2. Selecting the **NEXT** button on the MCDU shows the radio page containing the HF radio frequencies, (RADIO page 2/2).

The HF window in page 2/2 shows the current active and preset HF frequencies along with their respective modes. Pushing the line select key 3L swaps the active and the preset frequencies. Additionally, there are four other MCDU pages that are used to control the HF system:

- HF DETAIL 1/2
- HF DETAIL 2/2
- HF MEMORY
- HF EMERGENCY SETUP.

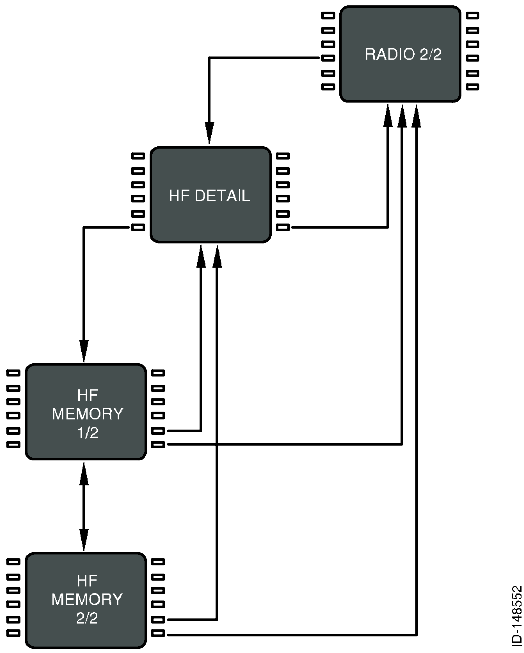


Figure 10-31
HF COM Radio Tuning Logic Diagram

HF Tuning Control

Frequency values are displayed in the format of XX.YYYZ (such as, 13.0500). The frequency can be changed using the scratchpad or the tuning knob on the MCDU.

To change a frequency value using the scratchpad, the new frequency value is entered using the keypad and the line select key next to the new frequency is pushed. This transfers the value from the scratchpad to the selected frequency when the scratchpad entry is valid. A valid scratchpad entry is in the format of XX.YYYZ, XXYYYZ (no decimal point), or XXYYY (last character not entered, assumed to be zero). The range of valid HF frequency values is 2.0000 to 29.9999.

To operate the MCDU tuning function use the steps described in the following paragraphs.

1. When the MCDU scratchpad is empty, push a line select key adjacent to an unboxed frequency field (active or preset) to move the tuning box to that field. Use the tuning knob to change the frequency.

2. Pushing a line select key adjacent to a boxed preset frequency field shows the detailed tuning page for that radio.

3. Pushing a line select key adjacent to an active frequency field swaps the preset frequency with the active frequency.

4. When the MCDU scratchpad contains a valid frequency, pushing a line select key transfers the scratchpad value into the adjacent field and clears the scratchpad.

5. When the frequency is not valid for the adjacent field, an **Invalid data** message is displayed in the scratchpad.

The format of the HF DETAIL page 1/2 is a function of the selected operational mode for the active and preset channels. The format of the currently active frequency and present frequency fields change as a function of the mode that was selected.

The active and preset values for the HF frequency/channel, mode and emission mode can be swapped.

When the cursor is set to the currently active frequency field (adjacent to line select key 1L), pushing line select key 5L toggles the active channel through each of the operation modes. When the cursor is located on the preset channel display field (adjacent to line select key 3L), toggling line select key 5L toggles the preset channel through each of the operation modes.

The HF detail page provides a means to start or stop a PAST. The status display shows **TEST** when the test is running and **PASS** or **FAIL** depending on the test result. The test result is shown for five seconds after the test stops. The HF radio PAST and status display is terminated upon exit from the HF detail page.

When the LSK 2L is pushed, the values entered for the preset frequency become the active frequency/channel, active mode and active emission mode of the HF radio. The values that were set for the active channel are moved to the preset.

When the active channel is set to an operational mode that supports duplex operation (split, ITU or emergency), the pilot can monitor the audio on the transmit channel to listen on the transmit frequency before talking on it. When a duplex mode is selected, the **MONITOR XMIT** prompt is displayed adjacent to 4L. Toggling the LSK 4L toggles the receive frequency between the displayed transmit frequency and the displayed receive frequency. When the transmit frequency is selected, the large font **MONITOR XMIT** prompt is displayed. When the normal receive frequency is selected, the annunciator is **MONITOR XMIT** in a small font.

The HF transmission requires the tuning of the antenna coupler to the selected frequency, a tuning cycle is triggered within the antenna coupler when a new frequency is selected on the MCDU and the push to talk (PTT) button is pushed. A **TUNING** message is annunciated during the HF radio tune cycle on the MCDU HF 1/2 page. A 1000 Hz tone indicates the tune cycle is in progress. The tone remains on until the tuning cycle is complete.

New frequency tuning results within 30 seconds. Retuning to a previously tuned frequency results within one second. When the HF radio fails to tune, **TUNE FAIL** is annunciated on the HF detail page. A scratchpad message is generated to indicate **TUNE FAIL**. This annunciator remains displayed until a new tune cycle is initiated by rekeying the mike, or a new frequency is selected to tune.

The HF detail 1/2 page can be accessed by pushing the LSK 4L adjacent to the HF preset frequency on the RADIO 2/2 page when the preset frequency is selected.

The HF1 communications detail pages for the simplex mode, as shown in Figure 10-32, split mode, as shown in Figure 10-33, and emergency mode, as shown in Figure 10-34, are described in the following paragraphs. These pages are used to control HF tuning (manually and from memory), HF tuning mode selection, transmit power selection, squelch, and to select the operating mode. The tuning functions work just like the VHF COM selections, but each of the tuning modes that HF radios give, (such as, simplex, split (duplex), emergency, and International Telecommunication Union (ITU) channel numbers), are selectable on this page.

Figure 10-32
HF1 Simplex Mode Page

Figure 10-33
HF1 Split Mode Page

Figure 10-34
HF1 Emergency Mode Page

- **1L ACTIVE Simplex Operation** – Simplex transmits and receives on the same frequency. LSK 1L shows the active frequency and active emission mode (EM). Pushing LSK 1L positions the format cursor into the active frequency. The frequency can be changed using the tuning knob or by typing a frequency into the scratchpad and pushing the 1L key, as shown in Figure 10-32.

- **Split Operation** – Duplex operates when transmission and reception frequencies differ. The 1L display shows the active receive/transmit frequency and the active EM. Pushing the line select once positions the cursor around the frequency. The frequency can be changed using the tuning knob, or by typing a frequency into the scratchpad and pushing the 1L key, as shown in Figure 10-33.

- **International Telecommunications Union (ITU) Operation** – A duplex operation with frequencies in accordance with the ITU channel designations. The 1L display shows the active ITU channel and the receive/transmit frequency and the active EM. Pushing this key positions the cursor around the active ITU channel and places the tuning curl to the right of the active ITU channel. The outer tuning knob changes the first two digits and the inner knob changes the last two digits.

- **Emergency Operation** – A single button access to six prestored emergency frequencies. The 1L display shows the active EMRG channel, corresponding ITU channel (when available), and the the receive/transmit frequency. Pushing the line select positions the cursor around the active EMRG channel and places the tuning curl to the right of the active EMRG channel. The outer tuning knob and inner tuning knob can be used to scroll through the six available EMRG channels.

  Pushing the line select a second time switches the EMRG channel to simplex format so that the receive and transmit values are the same. When the HF radio is invalid, amber dashes (- - -) replace the active frequency value.

- **2L TRANSFER** – The active and preset values for frequency/channel, mode and emission mode can be swapped by pushing the 2L key. This transfers the values entered for the preset to the active frequency/channel, active mode and active emission mode of the HF radio. The values that were set for the HF radio are moved to the preset. The preset feature is not available when in split mode.

- **3L Simplex Operation** – The 3L display shows the preset frequency and preset emission mode. Pushing the 3L key positions the cursor around the first two characters of the preset frequency and places the tuning curl symbol to the right of the preset frequency.

  Split Operation – The 3L display shows the preset receive/transmit frequency and preset emission mode. Pushing the 3L key once positions the cursor around the first two characters of the preset receive frequency, and places the tuning curl symbol to the right of the preset receive frequency. Pushing the 3L key a second time positions the cursor around the first two characters of the preset transmit frequency, and places the tuning curl symbol to the right of the preset transmit frequency.

  ITU Operation – When the ITU operational mode for the HF is selected, the HF detail page 1/2 gives selection of one of the 249 ITU maritime radio telephone network channels.

The 3L display shows the preset ITU channel and the preset emission mode. Pushing the 3L key positions the cursor around the preset ITU channel and places the tuning curl to the right of the preset ITU channel. The outer tuning knob changes the first two digits and the inner knob changes the last two.

Emergency Operation – When the emergency operational mode for the HF is selected, the HF detail page 1/2 gives selection of one of six emergency channels on the emergency setup page.

The 3L display shows the preset EMRG channel, corresponding ITU channel (when available), and corresponding receive and transmit frequencies. Pushing the 3L key positions the cursor around the preset EMRG channel and places the tuning curl to the right of the preset EMRG channel. The outer tuning knob and inner knob can be used to scroll through the six available EMRG channels. When the HF radio is invalid, amber dashes (- - -) replace the preset frequency value.

- **4L Monitor Transmit** – The line select 4L is functional when the active operational mode is either SPLT, ITU, or EMRG. Pushing the 4L key sets the receive frequency to the transmit frequency. This enables the pilot to listen on the transmit frequency before talking on the transmit frequency. When line 4L is pushed, the active receive and transmit frequency shown at 1L does not change but the MONITOR TRANSMIT annunciator is displayed. Pushing 4L again sets the receive frequency back to the value displayed at 1L and changes the annunciator to MONITOR XMIT.

- **5L Set Operational Mode** – The operational mode for the active or preset can be modified by toggling the 5L key. The operational mode sequences through the four choices – Simplex (SMPL), Split (SPLT), Emergency (EMER), or ITU. The currently selected mode is green, the other four are white.

  When the format cursor is located on the active frequency, pushing 5L changes the active operational mode. When the format cursor is located on the preset frequency, pushing 5L changes the preset operational mode. When the format cursor is not located on the active or preset frequency, the 5L is not operational. When the HF radio is invalid, all three choices are displayed in white.

- **6L MEMORY/EMRG SETUP** – When the active operational mode is SMPL, SPLT, or ITU, pushing 6L branches to the HF memory 1/2 page. When the active operational mode is EMRG, pushing 6L branches to the emergency setup page.

- **1R Set Squelch Type** – The 1R key toggles through the different squelch types. The selected type is green. Each push of the key changes the next selection from white to green. There are four possible choices for squelch type – SQL, SQH, SBL, and SBH. They are defined below:

  — **SQL** is a straightforward signal to noise ratio squelch.

  — **SQH** squelch operates on the ratio between total audio power in the voice frequency range, to the total audio power in the frequency range above 3000 Hz.

  — **SBL** squelch opening is based on the amount of detected syllabic envelope relative to a DC reference.

  — **SBH** squelch opening is based on the software logic between a greater amount of noise and DC reference determined in the SBL mode.

- **3R Squelch Level** – The squelch level for the HF radio is set by pushing the 3R key. The squelch level entries vary depending on the squelch type that is selected at the 1R line select.

  SQL or SQH – For these two types, the squelch level is a numeric value between 0 and 31. This value can be entered two ways:

  1. The value can be entered in the scratchpad. Push the 3R key. The value must be between 0 and 31 for the entry to be accepted.
  2. The 3R key can be pushed. Use the tuning knob to adjust the value. Either knob can be used. One click clockwise increments the squelch level by one and one click counterclockwise decrements the squelch level by one. The squelch level value (0 to 31) is displayed in a large white font.

  SBL or SBH – For these types of squelches, the 3R key is used to toggle through the different squelch levels. The selected level is green. Each push of the key changes the next selection from white to green. There are four possible choices for squelch level – OFF, LO, MED, and HI. When the HF radio is invalid, the squelch level is displayed by amber dashes (- - -).

- **5R** – The 5R key is used to toggle through the different emission modes. The selected mode is green. Each push of the key changes the next selection from white to green. There are six possible choices for emission modes, they are listed and defined in the following paragraphs:

  — Upper sideband voice (UV)

— Lower sideband voice (LV)
— Upper sideband data (UD)
— Lower sideband data (LD)
— Amplitude modulation (AM)
— Reduced carrier (RC)

The UD and LD modes are given for interface with an external modem and are currently not used on the AW139/AB139.

When the operation mode is set to simplex or split, the HF detail page permits the HF emission mode for the currently active channel and the preset channel to be set to UV, LV, AM, or RC.

When the MCDU cursor is set to the currently active frequency field (adjacent to LSK 1L), toggling LSK 5R toggles the active channel through each of the available emission modes.

When the cursor is located on the preset channel display field (adjacent to LSK 3L), toggling LSK 5R toggles the preset channel through each of the emission modes. The band value cannot be changed when in emergency mode. The band for emergency HF radio tuning is always UV.

- **6R RADIO 2/2** - Pushing this key shows the RADIO 2/2 page.

HF Detail Page

The HF 2/2 detail page, as shown in Figure 10-35, is used to specify a clarifier value, transfer HF control, and set the power level for the HF radio.

The HF radio 2/2 page can be accessed by selecting the **NEXT** button on the MCDU when the HF detail page 1/2 is displayed. The HF 2/2 page gives the ability to control the HF clarifier value. The clarifier offset is reset to zero when a new HF frequency is tuned.

In addition, the HF radio 2/2 page gives a quick method for accessing the HF memory page and for returning to the RADIO 2/2 page.

NOTE: The clarifier is not normally used in AM mode.

Figure 10-35
HF 2/2 Detail Page

- **1R Clarifier** – The listener uses the clarifier function to slew the receiver frequency up and down 250 Hz from the displayed frequency in 10 Hz increments. (This clarifier is not used in AM mode.) This compensates for minor frequency shifts between the transmitter and receiver due to propagation, Doppler shift, and other factors. The clarifier level for the HF radio is set by pushing the 1L key. The value can be entered through the scratchpad or by using the tuning knob. The value must be between –250 and 250 to be accepted.
- **6L MEMORY** – Pushing the 6L key shows the HF MEMORY page described in the following paragraphs.
- **1R TX POWER** – The TX power for the HF radio is set by pushing the 1R key. The TX power affects upper and lower sideband operation. AM and data modes are not affected. Pushing 1R toggles through the three choices – LO, MED, and HI. The **active** setting is green, the others are white. When the HF radio is invalid, all three choices are displayed in small white font.
- **6R RADIO 2/2** – Pushing 6R returns the MCDU to the RADIO 2/2 page.

HF MEMORY 1/2 and 2/2

The HF MEMORY consists of two pages, 1/2 and 2/2. HF MEMORY 1/1, as shown in Figure 10-36, is described in the following paragraphs. HF MEMORY pages 1/2 and 2/2 function the same as the VHF COM and VHF NAV memory pages, but have a slightly different appearance due to the need to support two line frequency displays (for split mode tuning). As a result, space limitations do not permit assigning labels to HF memory locations.

The HF MEMORY pages can store up to 12 HF radio presets. The operation mode, emission mode and frequencies are stored for each memory channel The page gives prompts to return to the HF 1/2 and RADIO 2/2 pages.

Figure 10-36
HF MEMORY 1/2 Page

Selecting line select key 6L on the HF detail pages one or two when the selected operational mode is simplex, split or ITU. Memory channels one through six are displayed on page 1/2 and channels seven through 12 are displayed on page 2/2. The page up and page down buttons can be used to move between the two memory pages. Access to HF MEMORY 2/2 is by the **NEXT** or **PREV** function buttons.

- **1L** – Pushing the 1L key tunes the HF radio with the values in the currently selected memory location. This includes the frequency/ channel, operational mode, and emission mode.

- **2L, 3L, 4L, 2R, 3R, 4R** – Pushing these keys positions the cursor at the selected memory location. The first push positions the cursor around the first two digits of the frequency value. When the memory location is in a split mode, the cursor is placed around the first two digits of the receive frequency. Pushing the key again when the memory channel is in split mode, moves the cursor to the first two digits of the transmit frequency.

- **5L OP MODE** – The operational mode for the selected memory location can be modified by pushing the 5L key. The key toggles through four choices – SMPL, SPLT, EMRG, or ITU. The **active** setting is green and the other settings are white.

  Place the cursor on the location of the mode that needs to be changed. The cursor location determines which memory location mode to modify.

- **5R EM MODE** – The emission mode for the selected memory location can be modified by pushing the 5R key. The key toggles through four choices – UV, LV, AM, and RC. The **active** setting is green and the other settings are white.

  Place the cursor on the location of the mode that is to be changed. The cursor location determines which memory location mode to modify.

- **6L HF1** – Pushing this key shows the HF EMRG CHAN SETUP 1/1 page.

- **6R RADIO 2/2** – Pushing this key shows the RADIO 2/2 page.

HF Emergency Channel Setup Page

The HF EMRG CHAN SETUP page, as shown in Figure 10-37, is used to modify preprogrammed emergency channels. The emergency frequency information on emergency (EMRG) channel one cannot be modified and is set to 2.1820 MHz. Modifications to the emergency channels are stored so they are not lost between power cycles.

Access to the HF emergency channel setup page is available from line select key 6L on the HF detail pages one or two when the selected operational mode is EMRG.

Figure 10-37
Emergency Channel Setup Page

When there is an ITU channel corresponding to the defined frequencies the channel number is displayed. When the channel is configured for duplex operation, toggling the adjacent line select key toggles the cursor between the transmit and receive frequencies to permit control of either frequency.

- **3L, 5L, 1R, 3R, and 5R** – Pushing these keys positions the cursor at the selected EMRG channel. The first push positions the format cursor around the first two digits of the frequency value. When the

EMRG channel is in a split mode, the cursor is placed around the first two digits of the receive frequency. Pushing the key again when the EMRG channel is in split mode moves the cursor to the first two digits of the transmit frequency.

- **6L** – Pushing the 6L key toggles the emergency channel where the format cursor is currently located between SMPL and SPLT. When the format cursor is on an emergency channel in SMPL mode, pushing the 6L line select changes the EMRG channel to SPLT mode. The **active** setting is green and the other setting is white.

NOTE: The HF emergency channel setup page permits the operation mode for emergency channels two through six to be set to SMPL SPLT mode.

- **DEL Button** – Pushing the **DEL** button returns the value of the EMRG channel where the cursor is currently located to the preprogrammed EMRG channel. This means the EMRG channels can be returned to their initial values.

HF EMERGENCY CHANNEL ABNORMAL OPERATION

When both transformer rectifier units (TRU) fail or in emergency conditions, the HF communication system does not operate. Under this condition, the crew can use the VHF communication system for shorter ranges.

The HF fail is annunciated with an amber dashed (- - -) line on the HF frequency on the MCDU.

When the HF coupler pressurization fails to support operation, the HF begins scaling the power back, which is displayed on the power settings of HF detail page 2/2.

When a pressure failure has occurred, the HF system assumes there is no pressurization in the coupler, so the system limits the output power to no more than 50W peak envelope power for single sideband operation and the following messages are displayed:

- HF POWER REDUCED on the scratchpad portion of the HF page on MCDU during flight

- When landing, HF COUPLER PRESSURE FAIL is displayed on the scratchpad of the MCDU.

When the HF coupler fails to tune to the selected frequency, a TUNE FAIL is annunciated both on the HF detail pages as well as in the MCDU scratchpad.

Backup Radio Tuning Page

The MCDU backup radio tuning page, as shown in Figure 10-38 is given to permit direct tuning of the on-side COM, NAV and XPDR. This backup tuning mode is used when an MAU, or NIM fails or a loss of the ASCB. The backup tuning mode can be used for control of radios on the ground without applying power to the rest of the avionics system.

Figure 10-38
BKUP RADIO Page

The MCDU backup tuning page is displayed when the MCDU loses ARINC 429 communication with the on-side MAU. It is displayed when the **RADIO** button is pushed when there is no ARINC 429 communication with the MAU. In addition, the page is displayed when the BKUP RADIO menu button is selected on the MCDU menu page.

The MCDU backup tuning page gives control of the on-side COM and NAV frequencies using the keyboard or the radio tuning knob. In addition, it controls the transponder code and operating mode for the on-side transponder. When operating the backup tuning mode, the altitude data from the ASCB is assumed to be unavailable and the available modes for selection are limited to standby and altitude off.

Automatic Direction Finder (ADF) 1 Page

The pages associated with the ADF system are shown in Figure 10-39.

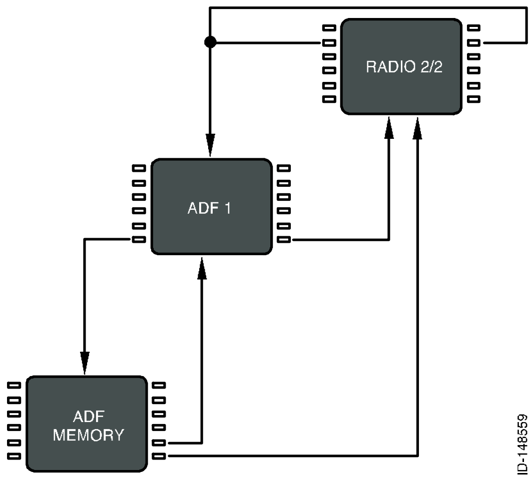


Figure 10-39
ADF Radio Tuning Logic Diagram

The ADF1 page, as shown in Figure 10-40, is described in the following paragraphs. An ADF detail page is given for each of the ADF radios. The ADF detail page is accessed by selecting the line key associated with the adjacent preselect boxed frequency in the RADIO page 2/2.

It shows the active, preset, and selected memory frequencies for the automatic direction finders. It shows the controls for the active mode (antenna or ADF), the beat frequency oscillators (BFO), and the VOICE setting (ON or OFF). In addition, it is used to access the ADF memory pages.

The ADF detail page gives a means to start or stop a PAST. The status display shows **TEST** when the test is running and **PASS** or **FAIL** depending on the test result. The test result is shown for five seconds after the test stops. The ADF radio PAST and status display is terminated upon exit from the ADF detail page.

Figure 10-40
ADF Page

- **1L Active ADF Frequency** – This section shows and controls the active ADF frequency on the selected radio in green. The white page title shows the ADF that was selected. Pushing 1L exchanges the active and preset frequencies, (when the cursor is on field 2L), or copies a frequency stored in memory, (when the cursor is on field 3L), for the selected ADF radio. A scratchpad entry into the field replaces the preset frequency with the previous active frequency.

- **2L Preset ADF Frequency** – This section shows the ADF preset frequency.

- **3L MEM TUNE** – This section shows and controls the ADF memory display. This is the default field for the format when the ADF page is displayed. Turning the tuning knob while field 3L is selected, cycles through the frequencies stored in memory by location, showing the associated label and the stored frequency below.

- **6L MEMORY** – Pushing this key shows the ADF MEMORY 1/2 page.

- **5R MODE** – Pushing this key toggles the ADF operating mode for the selected ADF. The active mode is in green.

- **6R RETURN** – Pushing this key shows the RADIO 2/2 page.

ADF MEMORY PAGE

The radio tuning function supports 12 ADF memories displayed on two pages. In addition to entering or dialing-in frequencies for each memory location, a text label of up to eight characters can be entered for each stored frequency. The default label for each memory is **MEMORY**, a dash, and the memory number, with the memory number always on the outboard edge of the display. The ADF MEMORY page, described in the following paragraphs, is shown in Figure 10-41.

Labels are entered by typing into the scratchpad and pushing the LSK adjacent to the desired frequency. When the radio tuning function determines that the entry is a valid frequency for the radio, the entry is accepted into the frequency field. When the entry is not valid, the entry is considered a label and it is entered into the label field above the frequency. A label can be replaced by making another scratchpad entry into a memory field, or by pushing the **DEL** button. Pushing the **DEL** button places the text DELETE in the scratchpad and, when entered on a memory field, deletes the associated text label, returning it to the default label. When the **DEL** button is used on a memory where there is no user-entered label, the frequency is deleted from memory.

Access to the ADF MEMORY 2/2 page by the **NEXT** and **PREV** function buttons.

Figure 10-41
ADF MEMORY 1/2 Page

- **1L ADF1** – This section shows and controls the active ADF frequency on the **selected** radio in green. The white title shows the ADF that was selected. Pushing 1L copies the field containing the cursor into the active frequency and moves the previously active frequency into the preset field. A scratchpad entry into the field replaces the preset frequency with the previous active frequency
- **2L, 3L, 4L** – These sections show the ADF memories 1–3, on ADF MEMORY 1/2 (7–9 on ADF MEMORY 2/2)
- **2R, 3R, 4R** – These sections show the ADF memories 4–6, on ADF MEMORY 1/2 (7–12 on ADF MEMORY 2/2)
- **5R ADF1** – Pushing this key shows ADF detail page
- **6R RADIO 2/2** – Pushing this key shows the RADIO 2/2 page.

Primary Flight Display (PFD) Radio

The PFD is a secondary means of radio tuning by the CCD to tune the selected COM/NAV channels and the transponder, as shown in Figure 10-42.

Figure 10-42
PFD Radio Displays

The COM and NAV active and standby frequencies are shown in boxes in the bottom left and right corners of the PFD display, as shown in Figure 10-42. The **active** frequency is displayed in green and **STANDBY** is displayed in white.

The purpose of this is to meet the availability requirements for the failure of a loss of all NAV and COM. In addition, it is to heighten pilot awareness of the state of the primary NAV and COM.

The frequencies are selected using the CCD. The item that is currently selected by the CCD is shown in an enlarged and highlighted box (the PFD cursor). The frequencies are tuned using the CCD knobs. The outer knob is used for radio frequency tuning integer portion and the inner knob is used for the decimal portion of the radio frequency. The CCD **ENTER** button selects a tuned frequency and swaps the active and standby frequencies.

When the FMS is selected on the HSI and no preview source is selected, the NAV tuning window shows the on-side NAV source. On power-up, each PFD defaults to show the on-side navigation source.

Each PFD gives tuning control of the transponder code. When the selected transponder is in standby mode, the transponder code is replaced with the STBY annunciator.

The annunciator for a single transponder installed is displayed as **XPDR**. When two transponders are installed the annunciator **XPDR1** or **XPDR2** are displayed according to the transponder selected on the MCDU.

Preselect tuning of the transponder code is synchronized between the pilot and the copilot PFD.

NOTE: Preselect tuning of transponder codes are not synchronized between the MCDU and the PFD.

The transponder code is amber dashed (- - -) when a transponder test is activated and for a short period of about five seconds after it stops.

RADIO INTERACTIONS

The radio tuning function receives an acknowledgement when the radio is successful in completing each tuning command. The MCDU sends the correct tuning command to the specified radio and waits for confirmation. When no confirmation is received within the timeout period, the frequency display on the page changes to amber and a scratchpad message is issued, as shown in Figure 10-43. The pilot can tune the radio again when the fault is transient or is cleared by crew action.

Figure 10-43
Amber Indications

Scratchpad Messages

The scratchpad messages, listed in Table 10-4, are generated by the radio tuning function. In the process of implementing this function, other required messages can be displayed.

Table 10-4
Scratchpad Annunciator Descriptions

ALERT	DESCRIPTION
DELETE	This annunciator indicates that the value in the scratchpad is deleted.
INVALID ENTRY	This annunciator indicates that the entry in the scratchpad is invalid.
SQNO RESPONSE FROM RADIO	This annunciator indicates that the squelch noise is coming from the radio.
STUCK MICROPHONE	This annunciator indicates that the microphone key is stuck.

AUDIO SYSTEM

AV-900 AUDIO SYSTEM OVERVIEW

There are two audio panels mounted at the top left and right of the cockpit center console in the AW139/AB139, one for the pilot and one for the copilot. The audio panel AV-900 Version 98202 is shown in Figure 10-44.

Figure 10-44
AV 900 Audio Panel

The cockpit audio system permits switching microphones to various radios, distribution of audio to headsets and interphone functionality. The primary interfaces in the audio system are the two digital audio buses from the MRC (one from each MRC) and the two digital microphone (MIC) buses. Both MIC buses are connected to each AV-900 and MRC in the system and contain identical data.

The audio panel is the central point of access for controlling the aircraft audio system. The AV-900 supports connection of up to eight crewmembers audio panels on the digital audio and microphone buses. It converts digital audio signals from the communication and navigation radios into analog signals that are audible in headphones, speakers and cockpit voice recorder (CVR) outputs.

The audio panel supports non-integrated radios such as the high frequency communications (HF COMM) radio.

Applying power to the avionics system powers up the COM, NAV, XPDR, DME, and ADF radios along with the audio panel and each MCDU simultaneously.

To increase mean time between failures (MTBF) and increase integration/control of functions, a single volume knob has been chosen for the AV-900. Because of this design, selection of an audio channel is required before the volume can be adjusted or before it can be deselected.

One microphone transmit selection is possible at a time, but listening on more than one audio channel at a time can be done. The default volume adjustment selection that appears in the LCD window is always the headphone volume.

The following scenario is included to help describe the operation:

1. The pilot has selected **COM1** to transmit and receive by pushing the **MIC.** This enables the microphone and audio (headphone) lines for COM1. The pilot adjusts the volume for COM1. After adjusting the volume (allowing 15 seconds to pass without further knob adjustments) it defaults to the headphone (HDPH) in the LCD window.
2. The pilot has tuned another frequency on COM2 and has requested and received a frequency change approval. The pilot selects the **COM2 MIC** button on the audio panel and is able to adjust the COM2 volume.
3. Suppose the pilot wants to monitor transmissions on COM1. This is accomplished by selecting the audio (**AUD**) button of **COM1**. The COM1 volume can be adjusted. With this setting, the pilot can listen to the transmission on COM1 and listen and transmit on COM2.

As noted in the scenario above, the display in the AV-900 defaults to the headphone volume setting after 15 seconds. There are two methods to select and readjust the volume on the other audio functions when the default HDPH is displayed.

1. The first method is to select the round **AUD** button for COM2 and hold it down for approximately two seconds and the volume of **COM2** is displayed so that the pilot can adjust it.
2. Suppose the **COM2** round **AUD** button is already selected (lit) and the pilot would like to readjust the volume. The pilot can push the **COM2** audio button twice to display the volume of COM2 so the pilot can adjust the volume. This action is turning OFF the audio, and back on again. When the **COM2** button is not selected, pushing the **COM2** button once shows the volume.

The audio system gives a low-level analog audio output to support the connection of a CVR to record the following data:

- Voice communication transmitted from or received by the flight deck by way of the attached radios.

- Audio signals from each pilots' microphone
- Voice communication of the flight crewmember using the interphone system
- Voice or NAV IDENT signals introduced into the headset or speaker
- Voice communication of flight crewmembers using the PA system.

Audio Selection Buttons

Four rows of round audio selection buttons, grouped side-by-side, are located on the audio panel. Pushing an audio select button permits the pilot to receive audio signals from the selected radio. Multiple radios can be selected enabling the pilot to maintain listening on other radio frequencies while communicating on a selected primary frequency.

Centered in each button is a green annunciator ( ) light that alerts the pilot to the condition of the radio. Pushing a microphone selection button connects the pilot to the associated radio enabling voice communications and lights the annunciator light. Pushing the button a second time disconnects the radio disabling voice communications and the green annunciator light turns OFF.

The buttons are marked and defined in the following paragraphs:

FIRST ROW – COMMUNICATION BUTTONS

The first row of communications buttons are shown in Figure 10-45

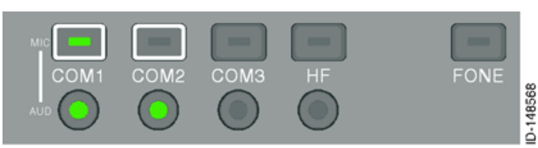


Figure 10-45
Communications Radio Control Buttons

- **COM1 Button** - Number one VHF communications radio. Pushing the **COM1 AUD** button activates/deactivates COM1 audio.

- **COM2 Button** - Number two VHF communications radio. Pushing the **COM2 AUD** button activates/deactivates COM2 audio.

- **COM3 Button** – The **COM3** button is the number three VHF communications radio. Pushing the **COM3** audio button activates and deactivates the COM3 audio.

ID-148571

- **HF Button** – Pushing the **HF** button activates and deactivates the HF audio. (option)

ID-148572

NOTES:

1. The **FONE** button on the top row of the audio panel supports communication devices such as satellite communications (SATCOM) radios/cell phones. It does not have an audio selection button that is separate from the microphone. Control of tuning other modes for the FONE are through a dedicated controller and are not available with the PRIMUS EPIC system.
2. One microphone selection button can be active at a time. Pushing another button deactivates the first and activates the new selection.
3. Pushing the microphone selection button for one of the radios automatically activates the audio selection for that radio.
4. The PRIMUS EPIC system gives an interface for a third, non-integrated COM radio. This radio can be VHF, FM, or UHF radio. Control of tuning and other modes for this radio is through a dedicated controller.

SECOND ROW – NAVIGATION BUTTONS

The second row of communication buttons are shown in Figure 10–46.

ID-148573

Figure 10–46
Navigation Radio Control Buttons

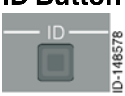
- **NAV1 Button** – Pushing the **NAV1** button activates and deactivates audio from the number one navigation radio.

- **NAV2 Button** – Pushing the **NAV2** button activates and deactivates audio from the number two navigation radio.

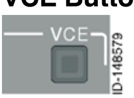
- **ADF1 Button** – Pushing the **ADF1** button activates and deactivates audio from the number one ADF.

- **ADF2 Button** – Pushing the **ADF2** button activates and deactivates audio from the number two ADF.

- **ID Button** – When the **ID** button is pushed, the ADF and NAV audio filter attenuates the voice audio so the Morse Code ident can be prominently heard.



- **VCE Button** – When the **VCE** button is pushed, the ADF and NAV audio filter attenuates the IDENT audio so the voice audio or Morse Code IDENT can be prominently heard.



THIRD ROW – NAVIGATION BUTTONS

The third row of communication buttons are shown in Figure 10–47.

Figure 10–47
Navigation Radio Control Buttons (Continued)

- **DME1 Button** – Pushing the **DME1** button activates/deactivates audio from the number one DME source.

- **DME2 Button** – Pushing the **DME2** button activates/deactivates audio from the number two DME source.

- **MKR (Marker Beacon) Button** – Pushing the **MKR** button activates and deactivates audio from the marker beacons.

FOURTH ROW – INTERNAL SYSTEM AUDIO CONTROLS

The fourth row of communication buttons are shown in Figure 10–48.

Figure 10–48
Internal Audio Control Buttons

- **SELCAL (Select Calling) Button** (option)– The system radios can be configured with select calling capability. When a SELCAL is received, the **SELCAL** button and the annunciator light for the proper radio flashes. The SELCAL function decodes all the VHF and HF COMM digital audio signals.

- **CAB (Cabin) Intercommunication System (ICS) Volume Control Button** – Pushing the **CAB** button connects pilot to the cabin ICS. Pushing the **PILOT** button on the cabin audio panel flashes the **CAB** button annunciator light. The **CAB** button on the pilot-side audio panel flashes and generates a single tone that is sent through the PA system and to the cabin audio controller.

  The acknowledgement of the cabin call by the cabin audio controller is indicated as a fast flash on the **CAB** button. When the **CAB** button is flashing fast, it establishes an audio connection between the cockpit ICS channel and cabin audio controller. This is indicated by a steady lighting of the CAB annunciator.

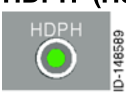
  The annunciator on the **CAB** button slowly flashes and a single audio tone sounds in the pilots' headset when a request for cabin ICS is initiated by the cabin audio system.

When the pilot pushes the **CAB** button after a call from the cabin, it establishes an audio connection between the cockpit and cabin. This is indicated by a steady light.

- **INPH Pilot Intercommunication System (ICS) Volume Control Button** – The **INPH** button connects and disconnects the pilot to the ICS.

- **VOX Voice-Activated Squelch (VOX) System Button** – Pushing the **VOX** button turns the VOX system and the associated annunciator light ON and OFF. With the VOX system ON, tuning the **VOL** knob in the lower right corner of the audio panel increases or decreases the VOX system sensitivity.

- **HDPH (Headphone) Pilot Master Volume Control Button** – Pushing the **HDPH** button turns the headphone master volume control ON and OFF. With the master volume control system ON, turning the **VOL** knob in the lower right corner of the audio panel increases or decreases the volume of all the active radios simultaneously.



Cabin Audio System

The AV-900 audio system enables communication between the cockpit and cabin. There are two options given for the electrical interface. However, the two cabin communications are consistent.

The cabin communication can be implemented using the Honeywell cabin audio controller or a generic cabin audio system interfaced by way of a conventional analog audio and call discretes.

Four buttons are grouped vertically in a white outlined **box** on the right side of the control head. The word **CAB** printed vertically on the right side of the outlining box identifies them as the cabin audio control buttons shown in Figure 10-49.

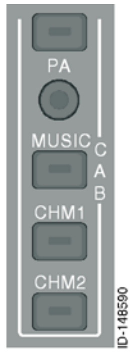
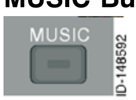


Figure 10-49
Cabin Audio Control Buttons

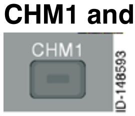
All of these buttons have the green annunciator ( ) light in the center. The cabin audio system control buttons are described in the following paragraphs.

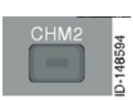
- **PA Button** - Pushing the **PA** button connects and disconnects the pilot microphone to the passenger compartment public address system. Pushing the button turns OFF any other previously connected microphone.

- **MUSIC Button** - Pushing the **MUSIC** button connects the cabin crew or passengers to the cabin entertainment system.



- **CHM1 and CHM2 Buttons** - When the **CHM1** or **CHM2** button is selected, the audio system turns ON the corresponding button annunciator and activates cabin visual annunciators, such as seat belts. These two buttons toggle ON and OFF.





The chime buttons operate when **CHM1** is pushed on the pilot-side audio panel, the **CHM1** button on both the audio panels lights. The same is true for **CHM2**. When one pilot turns a chime OFF, the annunciator goes out on both panels.

- **VOL (Volume Knob)**– A volume control knob is positioned in the bottom right corner of the audio panel next to the control window.

Change the audio volume of a radio using the following steps:

1. Push the button associated with the desired radio to do the following:

    - Annunciate the selected radio and current volume setting in the display window

    - Activate audio

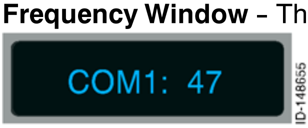
    - Light the green annunciator ( ) light on the button.

2. Change the volume of the selected radio by turning the volume control knob clockwise to increase volume and counterclockwise to decrease volume.

NOTE: The volume control knob controls the volume of the radio displayed in the control window. The exception is selecting the headphone (**HDPH**) button. When HDPH is displayed in the control window, the volume control knob adjusts the volume of all selected radios simultaneously.

- **BKUP Button** – When the **BKUP** button is in the ON position, the headset normally connected to that audio panel is connected to the opposite side audio panel to give backup intercom system (ICS). Pushing the **PTT** button connects the pilot microphone to the on–side communications radio.

- **Frequency Window** – The frequency window, found just to the left of the volume control knob, shows the selected radio and the current volume setting. It shows some messages.



GENERIC CABIN ICS AUDIO INTERFACE

The AV–900 audio panel system enables interface and operations for a generic cabin ICS audio controller. The audio interface permits paging and cabin communication with the cockpit crew. The following paragraphs contain the interface operational functions for the generic cabin ICS controller.

The AV-900 gives the following set of discrete inputs and outputs to facilitate two-way paging between the cockpit audio panels and the cabin audio system:

- A **Call In** pin is given to permit the generic cabin controller to page the cockpit crew.
- A **Call Out** is given to permit the cockpit crew to page personnel using the cabin audio system or to acknowledge a cabin page.
- A **Cabin Acknowledgement** to the AV-900 is given to permit the generic cabin controller to acknowledge a cockpit crew page.

When a call is initiated from the cabin, a **Call In** is received by the AV-900. When the **Call In** signal is received, the **CAB** button annunciator ( ) on the cockpit audio panel slowly flashes and plays an audio tone.

When the cockpit crew is ready to communicate with the cabin, they accept the incoming call by pushing the **CAB** button.

When the **CAB** button is pushed when the annunciator is flashing, the audio interface with the cabin audio system is enabled and the CAB annunciator shows a steady annunciator.

The cockpit crew can initiate a call by pushing the **CAB** button. When the **CAB** button is pushed, an audio tone plays through the right cockpit speaker PA and the CAB annunciator slowly flashes.

The cabin audio system can acknowledge a call from the cockpit. When the **CAB** button is flashing slowly and the acknowledgement is set, and an audio tone plays in the pilots' headset and initiates a fast flash of the **CAB** button.

When the **CAB** button is pushed, the audio interface with the cabin enables and a steady light is displayed on the CAB annunciator.

MAINTENANCE COMMUNICATIONS

The cockpit audio system supplies an interphone port that can be used by maintenance or ground support personnel. The audio panel does not have a dedicated control for the maintenance port headset volume. Use of headsets with an integrated volume control enables maintenance personnel to adjust the headset volume up to the limit defined by the configuration setting. The maintenance ports are connected to the pilots ICS at all times.

Pushing the **INPH** button enables the maintenance port lines. The maintenance port one is dedicated for use with the backup ICS mode. External headsets must not be connected to maintenance port one.

BACKUP ICS MODE

Each audio panel has a backup mode that can be selected when one of the audio panels fail. The backup mode permits the pilot headset to be connected directly to the on-side VHF COMM or off-side audio panel ICS.

No power is required to the on-side audio panel. Switching the pilots MIC between the COM radio and the off-side maintenance port is performed by an external relay controlled by the **PTT** button.

The audio panel backup mode controls the ICS and COM audio volume through the use of a single volume control knob. The control knob is located on the lower left corner of the audio panel and labeled BKUP. The ICS and COM audio volumes cannot be adjusted separately.

CABIN AUDIO CONTROLLER

The cabin audio controller, shown in Figure 10-50, is mounted in the overhead (ceiling) of the cabin.

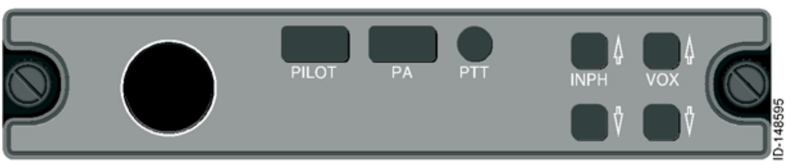


Figure 10-50
Cabin Audio Controller

The cabin audio controller is intended for use by a single cabin operator. The cabin audio controller includes a headset jack and enables interphone communication with the flight crew and public address functions for communication with other passengers.

The buttons on the cabin audio controller head are used to control specific functions of the audio system. Pushing the buttons activates the respective function. Pushing the button again deactivates the function. The cabin audio controller buttons and their functions are described in the following paragraphs.

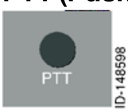
- **PILOT Button** - The **PILOT** button activates the cabin intercommunication system (ICS). It supplies cabin crew or passengers a discrete means of contacting the pilot by flashing the **CAB** button on that audio panel, and a chime is sounded in the headset. The **CAB** button on the audio panel continues to flash and the chime sounds until it is selected by the pilot or deselected by the cabin operator.

The acknowledgement and connection from the cockpit crew results in a steady lighting of the **PILOT** button.

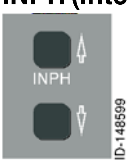
When the PILOT annunciator is ON, the cabin operator can listen and talk on the cockpit ICS.

- **PA (Public Address) Button** - Pushing the **PA** button connects cabin crew or passengers to the public address system. The PA audio is available through the right speaker output.

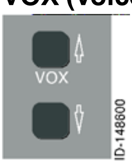
- **PTT (Push-To-Talk) Button** – Pushing the **PTT** button enables the pilot to speak over the public address system.



- **INPH (Interphone) Buttons** – The **INPH** buttons are used to control headset audio volume control. Pushing the button beside the up arrow increases headset volume, pushing the button beside the down arrow decreases headset volume.



- **VOX (Voice Activated Squelch) Buttons** – The buttons are used to control **VOX** volume control. Pushing the button beside the up arrow increases headset volume, pushing the button beside the down arrow decreases headset volume.



AV-900 Versions 98601 and 98602 Cockpit Audio Panel

The AV-900 audio panel Versions 98601 and 98602, adds buttons **COM4**, **HOIST** and **DF** to the previous version 98202 audio panel. In addition, **CHM1** and **CHM2** are replaced with **NO SMK** and **SEAT BLT**. In addition, the **AUTH** button is included in this panel. The AV-900 Version 98601 and 98602 is shown in Figure 10-51.

The AV-900 version 98602 can be mounted in the cabin for use by the hoist operator. This version has receive-only access to **COM1** and **COM2**. For example, the **MIC** buttons are disabled. When the **COM1** and **COM2** buttons are pushed, there is no response from the audio panel. No response to pushing a button is not acceptable for a cockpit audio panel, but it is acceptable for a cabin panel. In addition, the **NO SMK** and **SEAT BLT** buttons are disabled and do not respond when pushed.

Figure 10-51
AV-900 Version 98601 and 98602 Audio Panel

NOTE: When a button is pushed that corresponds to a function that has been disabled, the audio panel shows **NO FUNCT** in the display window when the button is being pushed.

- **PA Button** – Pushing the **PA** button connects and disconnects the pilot microphone to the passenger compartment public address system. Pushing the button turns OFF any other previously connected microphone.

The AV–900 version 98601 gives a PA PTT ground/open discrete that indicates when the PA PTT is activated on any audio panel mounted in either the cockpit or cabin.

When the AV–900 hoist operator panel version 98602 is installed in the cabin, the PA PTT priority for the pilot (AV–900), copilot (AV–900) and the hoist operator panel is as follows:

— Pilot PA PTT has priority over copilot and hoist operator/cabin PA PTT.

— Copilot PA PTT has priority over hoist operator/cabin PA PTT.

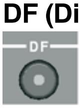
- **COM3 and COM4 Button** – The PRIMUS EPIC system supplies an interface for two additional non–integrated COM radios. These radios are designated as COM3 and COM4 and can be VHF or UHF radios. Control of tuning and other modes for these radios is by way of a dedicated controller.

- **NO SMK and SEAT BLT Buttons** – The **CHM1** and **CHM2** buttons are replaced with **NO SMK** and **SEAT BLT** respectively. The functions of the buttons are unchanged making this a name change only.

These buttons do not respond when pushed in the 98602 version.

- **HOIST Button** – The PRIMUS EPIC system enables analog audio from the POLYCON SAR communication system and interfaces for up to six AV–900 audio panels in the cabin for hoist operators. A microphone can be connected to the POLYCON SAR communication system. Selection of the microphone enables transmission. This is the equivalent to a **HOT MIC** condition when the transmit button is pushed.

- **DF (Direction Finder) Button** – A typical DF system is the Chelton 935–2 system. The control of tuning and other modes is by way of a dedicated controller.



- **AUTH Button** - The **AUTH** button gives a means for the cockpit crew to control access to particular radios that are on the cabin audio panels. This function permits the cockpit crew to enable or disable transmission or reception for each radio on the audio panels in the cabin.

NOTE: Version 98601 shows NO FUNCT when the **AUTH** button is pushed.

BACKUP ICS MODE

The AV-900 version 98601 audio panel supports the backup ICS function requirements described for the AV-900 Version 98202.

The AV-900 version 98602 audio panel mounted in the cabin has a backup mode that can be selected if the audio panel fails. The backup mode permits the crew members headset to be connected to another audio panel to provide a backup ICS function. No power is required for a failed audio panel. The following requirements are applicable to the backup mode:

- The AV-900 version 98602 audio panel supports a backup mode that connects crew members headset directly to the maintenance input of another audio panel. This ensures availability of the ICS system after failure of one audio panel.

  the first AV-900 audio panel mounted in the cabin is connected to the maintenance input of the pilot-side audio panel. When multiple Hoist Operator Audio Panels are installed in the cabin, the backup buttons on these are daisy chained so that each audio panel is backed up by the next audio panel in the sequence.

- The 98602 audio panel backup mode supplies control of the ICS audio volume through the use of a mechanical volume control knob. The control knob is located on the lower left corner of the audio panel and is labeled **BKUP**.

AV-900 Version 988 Hoist Operator Audio Panel

The AV-900 Version 988 Hoist Operator audio panel is used in the cabin along with the pilot and copilot AV-900 Version 986 audio panels. It enables the intercom link and interface with the POLYCON SAR communication system. In addition, the Hoist Operator has access to the COM3, COM4, HF, FONE, PA, ADF1, ADF2, and DF functions. The AV-900 Version 988 is shown in Figure 10-52.

Figure 10-52
AV-900 Version 988 Audio Panel

BACKUP ICS MODE

The AV-900 supports a backup mode that connects the crewmembers headset directly to the maintenance input of another audio panel. This ensures availability of the ICS system after failure of one audio panel. The first AV-900 is mounted in the cabin and is connected to the maintenance input of the pilot-side audio panel. When multiple Hoist Operator audio panels are installed in the cabin, each audio panel is backed up by the next audio panel in sequence.

The audio panel backup mode gives control of ICS audio volume through the use of a mechanical volume control knob. The control knob is located on the lower left corner of the audio panel and is labeled **BKUP**.

PASSENGER ADDRESS

The AV-900 Version 988 Hoist Operator **PA** button routes the microphone and PTT to the PA system. The PA audio panel volume control affects or adjusts the side-tone output level on the audio panel.

The PA PTT priority for the pilot, copilot, and Hoist Operator panel is as follows:

- Pilot PA PTT priority over copilot and Hoist Operator/Cabin PA PTT
- Copilot PA PTT priority over Hoist Operator/Cabin PA PTT.

11. Radio Altitude (RA)

INTRODUCTION

The RA data is displayed in two locations on the PFD. First, as the low altitude alert display (LAAD) which is part of the altitude tape when the aircraft is approaching the ground. This is designated by an amber line and brown shading. Secondly, a separate RA tape is displayed in the bottom right hand corner of the PFD. Both are shown in Figure 11-1.

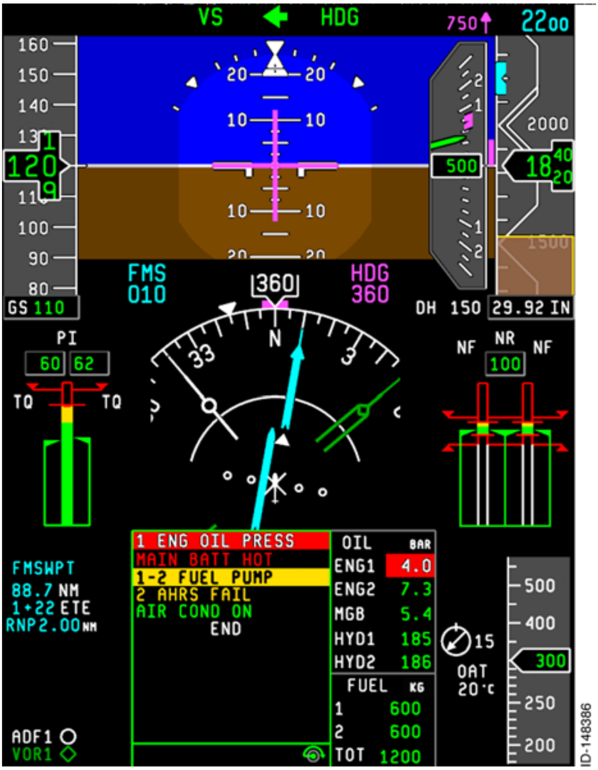


Figure 11-1
Radio Altitude Displays on the PFD

RADIO ALTITUDE TAPE DISPLAY

When the radio altitude is in use, it is displayed on the bottom right hand corner of the PFD, shown in Figure 11-2. This shows altitudes less than 1000 ft or whenever the radio height (RHT) mode is engaged.

When the RHT is not engaged, the radio altitude tape is removed from the display when the indicated altitude ascends past 1100 ft and redisplayed when the indicated altitude descends below 1000 ft.

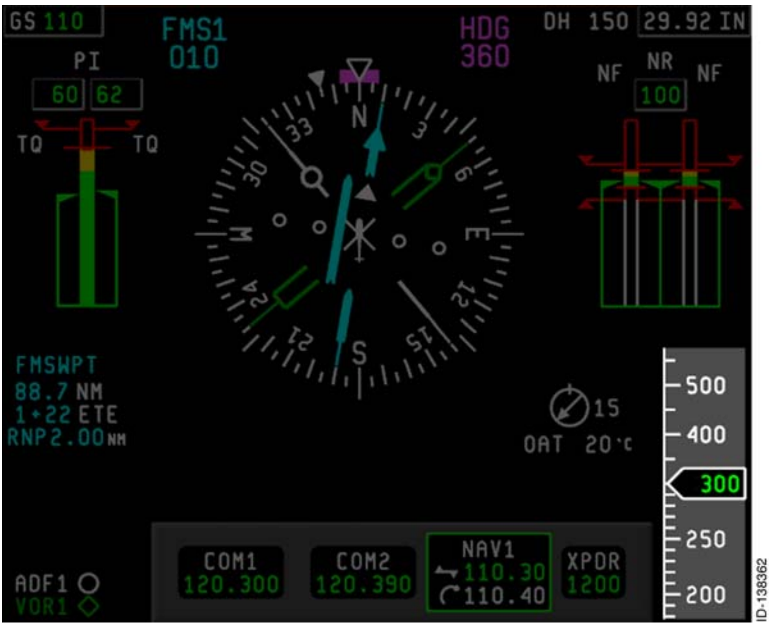


Figure 11-2
Radio Altitude Position (Full Compass Mode)

When the radio altitude test is active, a **TEST** annunciator is displayed on the radio altitude tape.

Radio Altitude Digital Readout – A digital readout for radio altitude is displayed for altitudes less then 2500 ft.

If the radio altitude tape is displayed, the digital readout is incorporated into the tape pointer. The digital readout is divided into 1-foot increments between -20 ft AGL and +250 ft AGL. Above that, increments are at 10 ft intervals from +250 to +2500 ft AGL and are rounded to the nearest 10 ft. The radio altitude information is removed from view above 2500 ft AGL. If the tape is not present, the digital readout is displayed below the triple tach display.

Brown **shading** of the RA tape is present below zero (0) ft. Gray **shading** is present above zero (0) ft.

Radio Altitude Source Selection– The PFD automatically selects the source for the radio altitude data. Each PFD displays radio altitude data from the on-side MAU, if that data is valid. If the on-side radio altitude data is invalid, the radio altitude data from the off-side MAU is displayed.

NOTE: When one radio altitude is installed, it is wired to both MAUs. When two radio altimeters are installed, each is wired to the on-side MAU.

Radio Altitude Source Annunciator – When two radio altimeters are installed and a PFD is displaying data from the off-side radio altitude sensor, the sensor is annunciated as either **RAD1** or **RAD2**.

Radio Altitude Test – During radio altitude test, the radio altitude is displayed regardless of the validity and a **TEST** annunciator is displayed.

Radio Altitude Miscompare – When a radio altitude miscompare is detected by the EDS monitoring software, a **RAD2** to **RAD** to **RAD2** annunciator flashes for the first six seconds and then shows **RAD** steadily above the radio altitude tape. Once the miscompare is no longer detected, the annunciator is removed.

The miscompare function is performed whether there are one or two radio altimeters installed. When only one radio altitude is installed, the miscompare function compares the same data from the two MAUs.

CAUTIONS

1. **IF RADIO ALTITUDE INFORMATION IS LOST, A RAD ANNUNCIATOR REPLACES THE RADIO ALTITUDE DIGITAL READOUT IN THE CENTER OF THE ALTITUDE TAPE.**
2. **THE RADIO ALTITUDE DISPLAY DURING THE RADIO ALTITUDE TEST PROCEDURE IS RELIABLE.**

WARNING

THE RADIO ALTITUDE MEASURES ABSOLUTE ALTITUDE ABOVE TERRAIN DIRECTLY BENEATH THE HELICOPTER. IT DOES NOT MEASURE ABSOLUTE ALTITUDE ABOVE TERRAIN IN FRONT OF THE HELICOPTER.

Color – The radio altitude display color scheme is as follows:

- **Green** – Radio altitude readout
- **White** – Radio altitude scale and digital readout box
- **Gray** – Raster shading on RA tape above 0 ft
- **Brown** – Raster shading on RA tape below 0 ft
- **Amber** – **RAD** miscompare annunciator and **TEST**
- **Red** – **RAD** radio altitude failure indication and box.

Decision Height (DH)

The DH is displayed as a digital readout located below the attitude sphere and to the right. The DH is set in the cockpit by the on-side display control (DC) function. The data range corresponds with the radio altitude range (<2500 ft). Upon power-up, the DH display defaults to blank values. The first control knob turn starts the display reading at 200 ft. Each knob click there after is at intervals of 10 ft. The DH display is removed for settings below 20 ft.

NOTE: A loss of valid DH setting from the DC function results in the DH display is amber dashed (- - -).

DH Minimum Indication

During descent, when radio altitude is equal to DH + 100 ft, an empty black box with an amber outline is displayed in the upper right portion of the attitude sphere. When RA is equal to or less than the DH setting, a **MIN** annunciator appears in the empty box on the attitude sphere. The **MIN** annunciator shares the location with the **VTA** annunciator. The **MIN** annunciator is inhibited on the ground and through climb out until RA is greater than DH + 100 feet.

NOTE: A loss of valid RA information on ASCB or valid DH setting from the DC inhibits the **MIN** annunciator.

RA Reference Bug and Readout

The RA reference digital readout is displayed directly above the RA tape when the RA hold flight director mode (RHT) is engaged. The set point is determined by the priority flight director.

The RA reference bug is displayed along the right inside edge of the RA tape corresponding to the RA reference digital readout. If the RA target is off scale, the direction that is off the scale is indicated.

NOTE: A loss of valid RA information from both MAUs, or loss of valid RA reference information from the priority flight director results in the reference readout and the bug is removed.

When the altitude alert function is active, the **bug** display is amber, when inactive the **bug** is magenta.

Barometric Altimeter Low Altitude Alert Display

The low altitude awareness display (LAAD) is an area of brown **shading** bordered by an amber **line**. The LAAD advances or recedes vertically along the altitude tape with changes in absolute altitude below 550 ft AGL. The display repeats the data from the LAAD display from the RA scale described in the following paragraphs. All data for the LAAD is derived from the RA.

As the aircraft descends though 550 ft AGL, the low altitude awareness display comes into view, initially presenting the amber **line**. As descent is continued, the amber line advances along the altitude tape, closing with the centerline, leaving the tape **shaded** brown behind it.

Since the centerline of the altitude tape corresponds to the artificial horizon line on the ADI, the advance of the amber line and brown shading along the altitude tape represents the aircraft closing towards the ground. The lower the altitude AGL, the greater the area of the altitude tape shaded brown.

The example at left shows the aircraft is presently on the ground at sea level. The lower portion of the altimeter tape is shaded brown to the horizon line and the present altitude window indicates an MSL altitude of zero feet.

Any gray **portion** of the altitude tape between the amber line and the artificial horizon represents absolute altitude AGL.

12. Air Data System (ADS)

INTRODUCTION

The ADS uses two air data modules (ADM) and two outside air temperature (OAT) probes. They supply data to the MAUs where essential air pressure and air temperature information is generated and distributed electronically to integrated avionics components that use it.

The ADS for the AW139/AB139 consists of the following components:

- Sensor inputs: ADM pressure signals
- Air data application (ADA) software
- Total air temperature (TAT) or outside air temperature (OAT) probe
- Barometric (BARO) pressure correction settings through the display controllers.

Each ADM senses static pressure (Ps) and total pressure (Pt) and supplies it to the ADA software in the MAU.

The ADA software combines the air pressure data from the ADMs with temperature information from the OAT probes and the altimeter setting input onto the PFD with the display controller. The combined data is used to calculate altitude, airspeed, and vertical speed. The calculated information is continuously displayed for the pilots use on the PFD and MFD.

The air data is used by the AFCS, both AHRS and the WX radar system. When installed, the information is supplied to the flight director, FMS (flight management system), and TCAS (traffic alert and collision avoidance system).

Air data probe information supplied to the air data computer includes the following:

Sensor information:

- Static pressure (Ps)
- Total pressure (Pt)
- Outside air temperature (OAT)
- Total pressure source error correction
- Impact pressure (Qc)
- Dynamic pressure (Qd)
- Static source error corrections (SSEC).

Altitude parameters:

- Pressure altitude (Hp)
- Baro correction (Baro)
- Baro corrected altitude (Hbc)
- Altitude rate (HR).

Airspeed parameters:

- Indicated airspeed (Vi)
- Calibrated airspeed (Vc)
- True airspeed (TAS)
- Overspeed warning
- Never exceed speed.

Air temperature parameters:

- Static air temperature (SAT)
- Total air temperature (TAT).

Barometric correction:

- CIOCAL function barometric correction data input
- Knob delta function
- Consuming other ADS barometric correction data
- Convert barometric correction
- Baro storage and retrieval.

The ADA calculates the aircraft altitude, airspeed and vertical speed with this information.

The ADS altitude, airspeed, vertical speed and temperature information are shown to the pilot by way of indicators on an electronics flight instrument system (EFIS). These air data parameters are used by other aircraft systems in order to perform their functions. These systems can include TCAS, AFCS, flight data recorder (FDR), FMS and radar systems.

The power index depends on the pressure altitude and uses the same air data source for the computation with priority to pilot ADS. When ADS2 test is initiated, the PI for both engines display amber dashes (- - -).

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13. Flight Management System (FMS)

INTRODUCTION

The function of the FMS is to give flight planning capability, navigation information, and flight performance data to cockpit personnel. The FMS manages flight details from aircraft takeoff to touchdown. These details encompass standard instrument departures (SID), standard terminal arrival routes (STAR), and nonprecision approaches with missed approaches. The FMS supports helicopter specific approaches supplied in the navigation database. The FMS gives detailed predictions regarding estimated time and fuel remaining along the entire flight plan. With this information, the FMS performs high accuracy, long-range, lateral and vertical navigation along the flight plan. To accomplish these functions, the FMS communicates with a variety of sensors to determine the most accurate aircraft position. A detailed description of the FMS functions are described in the, Flight Management System (FMS) Software Version NZ 7.01 for the Agusta Bell A139 Helicopter A28-1146-181.

Role Within Overall Cockpit

The FMS gives complete flight planning capability including predictions of fuel and time. Once programmed, the FMS can supply control outputs to the autopilot system to fly the aircraft along the planned route, both laterally and vertically. The FMS supplies the EFIS (electronic flight instrument system) with the flight plan and status information for display.

EPIC FMS Interface Description

Table 13-1 lists the major systems that the FMS interacts with within the EPIC system.

Table 13-1
EPIC Interface Description

System	Description
ADS (Winds)	The FMS uses altitude, airspeed, and temperature data from the air data system (ADS) to calculate progress information.

Table 13-1 (cont)
EPIC Interface Description

System	Description
APM	Some of the functionality in the FMS can be enabled or disabled through selection of option switches located in the aircraft personality module (APM). On aircraft power-up, the FMS receives system and configuration data from the APM.
Fuel System	The fuel system gives the FMS information relating to the fuel on board to enable the FMS to execute performance and progress calculations.
EEC	The EEC 422 supplies engine fuel flow information. This information is used to perform fuel calculations.
MRC	Each MRC gives navigation data to the FMS including VOR, DME, and localizer information. The FMS is permitted to tune the NAV radios within guidelines.
Weight-On-Wheels	A weight-on-wheels signal sent by the monitor warning function is used by the FMS for determining the completion of the flight.
FDR	The FMS supplies required parameters that are recorded by the flight data recorder.
CMC and BIT	The CMC records BIT testing and maintenance information from the FMS.
MWF	The MWF uses data from the FMS to generate CAS and aural messages related to the FMS.
MCDU	The MCDU gives a user interface with the FMS system where the crew can enter the FMS data. Each MCDU shows the FMS data to the crew.
GPS	The FMS uses inputs from the GPS by way of the A429 to calculate aircraft position and perform navigation functions. The GPS gives the primary date and time information to the FMS.
EDS (PFD/MFD)	The EDS and the FMS communicate to relay the source and format of FMS display information.
AHRS	The FMS uses inputs from the AHRS to perform navigation functions.

Table 13-1 (cont)
EPIC Interface Description

System	Description
AFCS	The FMS is a source of navigation commands and flight data for the flight guidance and control system, giving LNAV and VGP.
Guidance Panel	The FMS uses the guidance panel inputs for activation/de-activation of LNAV and VNAV modes (for example, VGP, LNAV, MOT)
Data Loaders	The data loader interfaces permits the FMS to transfer data to and from the FMS. Either the DMU or a PC used as a data loader can be used to transfer databases and flight plan data. The data loaders send and receive the FMS data through the LAN.

Couple Source Selection

The direction of the PFD select arrow on the GC-810 guidance controller determines the FMS priority. The FMS priority is the FMS that is displayed on the PFD and is indicated by the select arrow on the guidance controller.

When the FMS is not displayed on the selected PFD, the priority FMS is displayed in the MAP or PLAN page on the MFD and is indicated by the select arrow on the guidance controller.

No FMS is priority when the selected display is in composite mode and the selected PFD has NAV as the primary navigation source.

Air Data System

The ADS uses two air data modules (ADM) and two outside air temperature (OAT) probes. They supply data to each MAU where essential air pressure and air temperature information is generated and distributed electronically to integrated avionics components that use it. ADS altitude, airspeed, vertical speed, and temperature information are used by the FMS.

The FMS shows information from a single ADS on the FMS AIR DATA page. The FMS uses the selected ADS on the same side of the cockpit (FMS1 = copilot and FMS2 = pilot). One exception is when the pilot has selected FMS2 for display and the copilot has selected FMS1, the FMS uses the cross-side selected ADS.

The FMS calculates and shows current density altitude on the AIR DATA page.

FMS Built-In Testing (BIT) and Central Maintenance Computer (CMC)

The BIT function consists of a set of tests performed following an application restart (power-up BIT) and a set of tests performed on a continuous basis (continuous BIT).

The intent of the BIT function is to ensure software and hardware integrity. Some of the BIT requirements are derived from the system level safety analysis when some requirements are based on engineering experience or good engineering practices.

The FMS software supplies built-in testing to ensure software and hardware integrity. In addition, the FMS communicates any failure of built-in testing to the CMC.

Fault Reports

The FMS reports to the CMC any FMS messages which are issued following a detected interface or an internal failure. However, the FMS does not need to report advisory messages to the CMC and not all alerting scratchpad messages need to be reported to the CMC.

MESSAGES

The FMS generates messages that alert the pilot to certain conditions. The messages are displayed in the scratchpad and the MSG annunciator is displayed on the PFD. Any entry already in the scratchpad is placed in a stack. The **CLEAR** button clears the message and shows the next message or entry from the stack. Correcting the reason for the displayed message clears some of the messages.

There are two types of messages generated by the FMS:

- Alerting
- Advisory.

FMS scratchpad messages are annunciated on the MCDU when either the FMS or radio systems are selected for MCDU control. During the MCDU control of the other subsystems, the scratchpad messages are queued for display and the pilot is notified when there is an alerting scratchpad message available by way of the MSG annunciator on the PFD. Advisory scratchpad messages do not activate the MSG annunciator. The scratchpad messages are automatically displayed when the MCDU (multifunction control display unit) control is returned to the FMS or radio systems.

A detailed description of the FMS messages are listed in the FMZ Series, Flight Management System A28-1146-124.

FLIGHT PLANNING OPERATION DESCRIPTION

The flight planning function enables the pilot to build, review, and modify flight plans by way of the MCDU. A flight plan is presented as a series of legs that are sequenced according to their occurrence during the flight. The legs are bounded by waypoints. A detailed description of the flight planning functions are described in the, Flight Management System (FMS) Software Version NZ 7.01 for the Agusta Bell A139 Helicopter A28-1146-181.

NAVIGATION OPERATION DESCRIPTION

The FMS navigation function is responsible for tuning the NAV and DME radios on the aircraft. The FMS chooses the best NAVAID to tune on the radios for VOR/DME or DME/DME radio position updates.

The FMS navigation function uses the NAVAID tuned by the radio tuning subsystem to compute a VOR/DME or DME/DME radio position. The FMS chooses the best position source among all navigation sensor inputs (for example, GPS, radio position, or AHRS) for FMS position updates. In addition, the FMS navigation subsystem is responsible for computing the aircraft ground speed, track, drift angle, wind direction and velocity. A detailed description of the navigation functions are described in the, Flight Management System (FMS) Software Version NZ 7.01 for the Agusta Bell A139 Helicopter A28-1146-181.

VERTICAL GUIDANCE OPERATIONAL DESCRIPTION

Vertical guidance (VNAV) is given by the FMS. Vertical guidance coupling to the autopilot is not given. VNAV computes TOC and TOD points and gives a vertical deviation for path descents. A detailed description of the vertical guidance functions are described in the, Flight Management System (FMS) Software Version NZ 7.01 for the Agusta Bell A139 Helicopter A28-1146-1.

DATABASE OPERATIONAL DESCRIPTION

The FMS relies on several database components to perform functionality. These components include:

- Navigation database
- Custom database

- Aircraft database.

The standard fixed wing navigation database consists of airports, airport procedures, navigation aid, and waypoint information that is used by the FMS to perform navigation functions. The navigation database is produced industrially every 28 days and is distributed for use in FMS systems. The navigation database generated for the AW139/AB139 contains heliports, short runways, helipads including helicopter departures and arrival procedures which are supplied to Honeywell by Jepessen.

The custom database consists of flight plans, pilot-defined waypoints, and NOTAMS.

The capacity of the custom database is:

- 1,000 pilot-defined waypoints (custom waypoints)
- 3,000 stored flight plans
- 45,000 total flight plan waypoints (pilot-defined and stored flight plans)
- Six NOTAMs (three temporary NOTAMs and three permanent NOTAMs).

The custom database is defined interactively through pilot interface with the FMS.

Custom data is entered through the flight plan, NOTAMs and the WAYPOINT DATA PAGE. Custom waypoints can be created by entering a waypoint name on the waypoint list page followed by the reference position information entered on the WAYPOINT DATA PAGE The waypoint list page is capable of accepting reference position information from the scratchpad for the purpose of generating a custom waypoint.

If a reference position is entered on the waypoint list page the waypoint data page is displayed and permits entry of a waypoint name to store the custom waypoint.

The aircraft database consists of aircraft specific parameters used in FMS performance calculations. The aircraft databases are produced by the FMS engineering department and are distributed along with the navigation databases.

Storage Requirements

The specific storage capacity requirements for each database is specified in the following subsections.

NAVIGATION DATABASE STORAGE REQUIREMENTS

The PRIMUS EPIC system gives the storage capacity for at least 16 megabytes of data for the FMS navigation database.

CUSTOM DATABASE STORAGE REQUIREMENTS

The PRIMUS EPIC system gives the storage capacity for at least 128 kilobytes of data for the FMS custom database.

AIRCRAFT DATABASE STORAGE REQUIREMENTS

The PRIMUS EPIC system gives the storage capacity for at least 32 kilobytes of data for the FMS aircraft database.

Loading Requirements

When the PRIMUS EPIC system is in a dormant state, the database module maintains storage of the navigation database, custom database, and aircraft database in a safe and secure environment. For the FMS to operate efficiently, these databases, or portions thereof must be accessible through direct memory addressing from the FMS processor card. For this purpose, the FMS processor card gives at least eight megabytes of nonvolatile random access memory (RAM) dedicated to database storage.

PERFORMANCE OPERATIONAL DESCRIPTION

The main objective of the performance function is to give estimates of time and fuel at every waypoint in the flight plan. There are two different MCDU selectable methods for making these estimates available to the user, **PILOT SPD/FF** and **CURRENT GS/FF**.

- **PILOT SPD/FF** – In this mode, performance uses a pilot–entered cruise airspeed and fuel flow to make time and fuel predictions for the entire flight.

- **Current GS/FF** – In this method, performance uses the current sensed GS and FF to perform predictions over the entire flight. This is the least accurate method for obtaining time and fuel predictions.

The Aircraft Database File

The aircraft database file contains all aircraft specific data needed for speed selection logic and MCDU displays.

The aircraft database file is stored in flash memory and is user accessible by the way of a dataloader.

FILE CONTENTS

The following information is contained in the aircraft database file and must be supplied by the OEM.

- Aircraft type
- Ceiling altitude
- Sea level maximum weight rate of climb
- Maximum change in fuel flow
- Number of engines
- Maximum takeoff weight
- Maximum ramp weight
- Maximum CAS entry permitted
- Gear placard speed
- Placard speed
- Reserve holding speed
- Maximum landing weight of aircraft
- Basic operating weight
- Maximum takeoff weight
- Takeoff fuel allowance
- Landing fuel allowance
- Climb speed CAS
- Cruise speed CAS
- Descent speed CAS
- Descent angle
- Departure speed
- Initial approach speed

- Initial approach distance
- Final approach speed
- Final approach distance
- Go around speed
- FL/MSL transition altitude
- Airspace speed limit altitude
- Airspace speed limit
- Average passenger weight
- Hold speed
- Maximum gross weight
- Minimum gross weight
- Basic center of gravity
- Maximum hoist weight
- Maximum hook weight.

FMS DIGITAL MAP OUTPUT

The FMS gives the following outputs necessary to support digital map A429 outputs from the custom IO module for moving map and route overlay.

- Present position latitude and longitude
- TO and FROM waypoint identifiers
- Flight plan waypoint bearing, latitude, longitude and identifier
- Desired track and track angle
- Distance to destination
- UTC (universal time constraint) time in hours minutes and seconds
- Ground speed and magnetic variation.

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14. Global Positioning System (GPS)

INTRODUCTION

This section gives information and procedures for checkout and operation of the GPS.

The GPS consists of one receiver and one antenna. It operates continuously and updates the flight management system (FMS) position. The GPS sensor module is located in the modular avionics unit two (MAU2).

The GPS module has a maximum of 12 channels that are capable of tracking NAVSTAR (navigation system with time and ranging) GPS satellite signals. There are 24 satellites in the entire GPS system. Only 12 are within line of site at any given time while the other 12 are on the other side of the planet (with the possible instance of high altitude flights over the poles). Therefore, the maximum satellite usage is 12, which is why each GPS module needs to simultaneously track a maximum of 12 satellites at a time.

The GPS receiver operations are transparent to the crew. The performance of the GPS system can be monitored (GPS 1 STATUS) by selecting the MCDU NAV menu button and selecting the POS SENSORS pages, as shown in Figures 14-1 and 14-2. This can be useful in extended overwater operations.

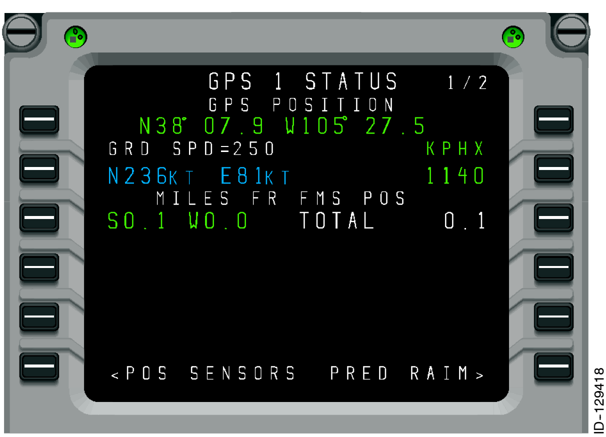

Figure 14-1
GPS 1 STATUS 1/2

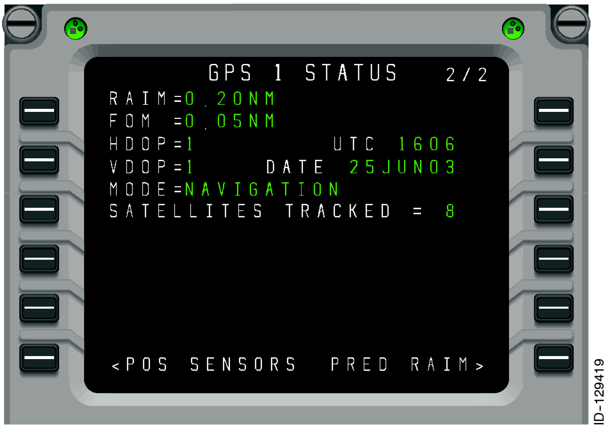

Figure 14-2
GPS 1 STATUS 2/2

Receiver Autonomous Integrity Monitor (RAIM)

The GPS supplies data to the flight management system (FMS) for flight guidance and other information for various phases of flight. Each GPS has RAIM outputs for the current position and time in the form of horizontal and vertical integrity limits (HIL and VIL). In order to compute RAIM, the GPS must have a minimum of five satellite signals. The FMS does not accept GPS data unless a valid RAIM figure is available.

The GPS has a predictive RAIM (PRAIM) function. PRAIM calculates the estimated value of the HIL at some future place and time, as shown in Figure 14-3. The FMS can interrogate the PRAIM function of the GPS through the ARINC 429 interface. However, RAIM integrity performance requirements cannot be selected with the GPS.

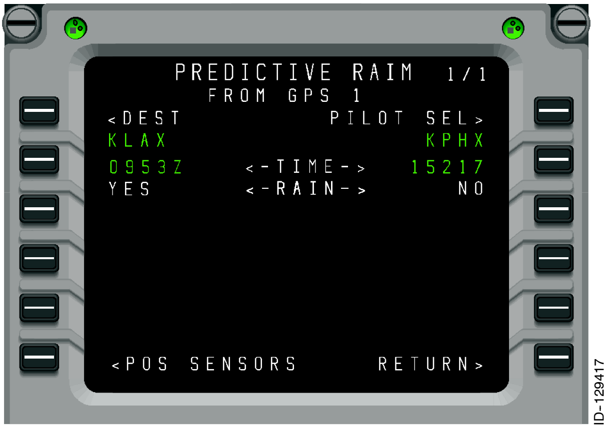

Figure 14-3
PREDICTIVE RAIM 1/1

The GPS module is compatible with future FAA wide and local area augmentation systems (WAAS and LAAS).

The module is compatible with future software upgrades to receive data from a datalink transponder (VHF datalink transponder or VDL) and/or ILS for GPS landing systems.

The GPS module supports initiated built-in test equipment (BITE) commands from the central maintenance computer (CMC) for the purpose of resetting the module and initiating the power-up BITE. The CMC interfaces with the GPS module by way of the ARINC bus.

The GPS sensor module and antenna meet the requirements of the technical standard order (TSO) C139A class C1/B1, C2/B2 and C3/B3.

DESCRIPTION

Physical Description

The GPS outputs figure of merit (FOM) data in meters, feet, and nautical miles. Table 14-1 lists the GPS performance functions.

The GPS interfaces with these devices or systems:

- GPS antennas
- NAVSTAR GPS satellite constellation
- Air data systems
- FMS.

Table 14-1
GPS Performance

Parameter	Performance (Selective Availability On/Off)
Present Position	100 meters/25 meters
Ground Speed	2.0 knots
Track Angle True	0.5 degrees
Vertical Velocity	200 feet per minute
Altitude	300 feet/100 feet
N-S/E-W Velocity	1.5 knots
Time	250 nanoseconds/100 nanoseconds
RAIM	Continuous and predictive
Flight Phases	Oceanic En route Terminal Nonprecision approach CAT 1 (requires WASS and/or LASS) CAT 2/3 (requires LASS)
Differential	WAAS (where available) LAAS (requires VIDL)
GLONASS	Planned (dependent of GLONASS status)

FUNCTIONAL DESCRIPTION

Each GPS is a 12-channel GPS receiver that receives the L1 transmissions from the NAVSTAR GPS satellite constellation. The GPS modules have the primary function of determining the aircraft position from the signal codes and carrier phases of the acquired satellite RF signals received by the GPS antennas. The output data includes:

- Three dimensional aircraft position and velocities
- Satellite position
- Pseudo range
- Delta range data.

The GPS RAIM function assures the integrity of the data transmitted by the device. The GPS has a continuous integrity level (limit) to the FMS that is used to determine if the GPS navigation data can be used for the current phase of flight. The GPS RAIM function can detect satellite failures. It isolates and removes failed satellites when it is tracking a sufficient number of satellites for measurement redundancy.

The FMS uses predictive RAIM to determine the integrity levels at specific locations/times to support a nonprecision approach and the flight planning activities of the pilot. The GPS has the following types of RAIM predictions:

- Destination
- Alternate waypoint.

The destination and alternate waypoint predictions are made at specific locations or they are the estimated time of arrival (ETA) when the FMS makes the request for flight planning purposes. Satellites can be manually deselected or enabled for destination and alternate waypoint predictions.

OPERATION

GPS Operating Modes

The GPS module uses 12 channels, each capable of tracking NAVSTAR GPS satellite signals.

The GPS module uses seven operating modes, shown in Figure 14-4, and one nonoperating mode. The module transitions between the modes automatically. The operation modes are as follows:

- Self-test
- Initialization
- Acquisition
- Navigation
- Altitude aiding
- Aided
- Fault.

The non-operating mode is as follows:

- Data load.

The GPS module receiver utilizes the commercial access (C/A) code of the NAVSTAR GPS satellite constellation and is capable of operation when selective availability (SA) is activated and deactivated.

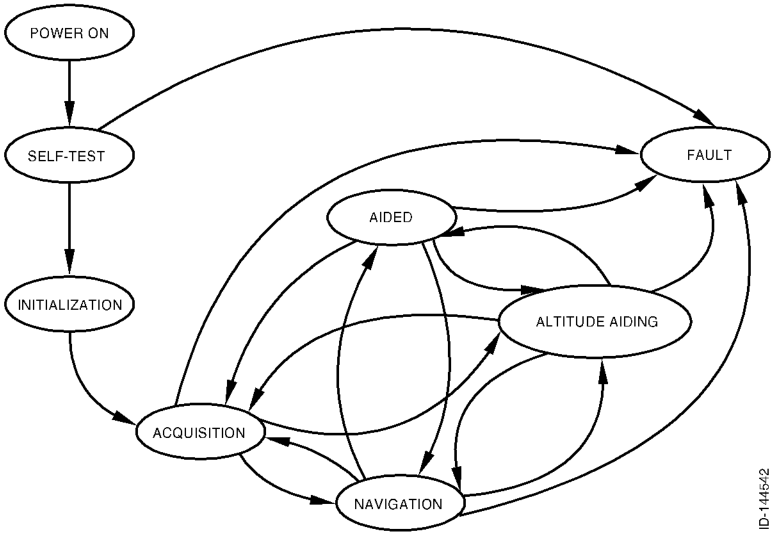

Figure 14-4
GPS Operating Modes

SELF-TEST MODE

The GPS is in the self-test mode for a maximum of five seconds from when it receives power until it completes all internal power-up built-in tests. When in the self-test mode, it does not output data on the ARINC 429 bus. When the self-test mode is completed, the GPS enters the initialization or the fault mode.

INITIALIZATION MODE

The GPS hardware is initialized after a BIT is successfully completed.

ACQUISITION MODE

The acquisition mode is entered from the initialization mode to acquire satellites, or other modes such as NAV or aided. When it does not have enough satellite and/or aiding data to remain in the NAV aided mode or altitude aided mode, the acquisition mode proceeds in a number of ways.

The GPS acquires satellites based on the information that it has when it enters the acquisition mode. To acquire satellites, the GPS uses the following data:

- **Almanac Data** – Almanac data determines the coarse the satellite orbits. The GPS stores almanac data in nonvolatile memory that does not require an internal or external battery for operational support.
- **Time** – Time is used with almanac data to estimate the present position of the satellites and their orbits.
- **Approximate GPS Location** – The approximate GPS location helps to predict which satellites are visible.

When the GPS has the information that is necessary to acquire satellites, it predicts which satellites are visible and then acquires those satellite signals. It collects satellite predicted orbital data by decoding the satellite downlink data message. When it acquires each satellite, the GPS begins to transmit the satellite measurement data for that satellite. When it is tracking at least five satellites, the GPS computes their positions and velocities and enters the NAV mode.

When the GPS does not have almanac and/or initialization data, it does a **Search the Skies** acquisition. To do this, the GPS tries to acquire all of the satellites in the GPS constellation. When it acquires the first satellite, it decodes the orbital data of the satellite from a downlink message. When it has acquired five satellites, the GPS enters the navigation mode. Without valid initialization data, the time-to-first-fix (TTFF) of a satellite is less than 10 minutes. With initialization and almanac data are available, the TTFF of a satellite is less than 75 seconds (95% confidence level).

NAVIGATION (NAV) MODE

NOTE: The FMS does not accept GPS data that is based on inputs from fewer than five satellites.

The GPS enters the NAV mode when it has computed a navigation solution that contains position, velocity, and time measurements. The GPS enters the NAV mode from the acquisition, aided mode, or altitude aided mode.

AIDED MODE

The GPS enters the aided mode when only four satellites are available, and uses the air data system (ADS) input for aircraft airspeed and altitude information. However, as is the case for the NAV mode, the FMS does not use GPS data in computing a blended navigation solution unless five satellites are available to compute RAIM. The pilot can access a GPS computed latitude/longitude from a minimum of three satellites by selecting the POS SENSOR from the FMS NAV menu, however, this information would only be useful to compare with IRU positions for dead reckoning piloting.

The aided mode uses inertial velocities to extrapolate the navigation solution and integrity monitoring during extended periods of insufficient satellite coverage and geometry.

The GPS enters the aided mode and altitude aiding mode when there are insufficient satellites tracked to remain in the NAV mode.

FAULT MODE

The GPS enters fault mode when the outputs are affected by one or more critical system faults. This mode supersedes all other modes of operation and remains active until the next power-up cycle.

ALTITUDE AIDING MODE

When satellite measurements are not sufficient for the GPS sensors to maintain integrity or remain in NAV mode, yet are sufficient when altitude information is available, the GPS is in the altitude aiding mode. This mode uses external altitude information to aid the navigation solution and integrity monitoring during extended periods of insufficient satellite coverage and geometry. The GPS enters the altitude aiding mode only after the pressure altitude has been calibrated with a geometric altitude solution using the GPS with sufficient integrity. When the calibrated pressure altitude standard deviation estimate is out of limits, the GPS reverts to the aided mode. The altitude aiding mode is entered from the NAV or aided modes and exits to the navigation, aided or fault modes.

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15. Attitude and Heading Reference System (AHRS)

INTRODUCTION

The attitude and heading reference system (AHRS) installed in the Agusta AW139/AB139 Helicopter is shown in Figure 15-1 in block diagram format. It is an attitude and direction sensing system that generates attitude and heading data that is used by the displays, the AFCS, the WX radar, and other systems of the helicopter.

The helicopter is equipped with two AHRS. Each one is an all attitude, inertial sensor system using fiber optic gyros (FOGs) and micro-mechanical accelerometers to compute the attitude, heading and flight dynamic information of the helicopter.

The FOGs and accelerometers are mechanically fixed or strapped down to the principle helicopter axes where it measures rates of change in pitch, roll, and yaw. A digital computer combines the rate of change data from the sensors to find and continuously update the pitch, roll, and heading condition of the helicopter.

Version 1105 AHRS is augmented with information from two magnetic sensor units (MSU) and two air data systems (ADS). Version 1115 AHRS is augmented by two global positioning systems (GPS).

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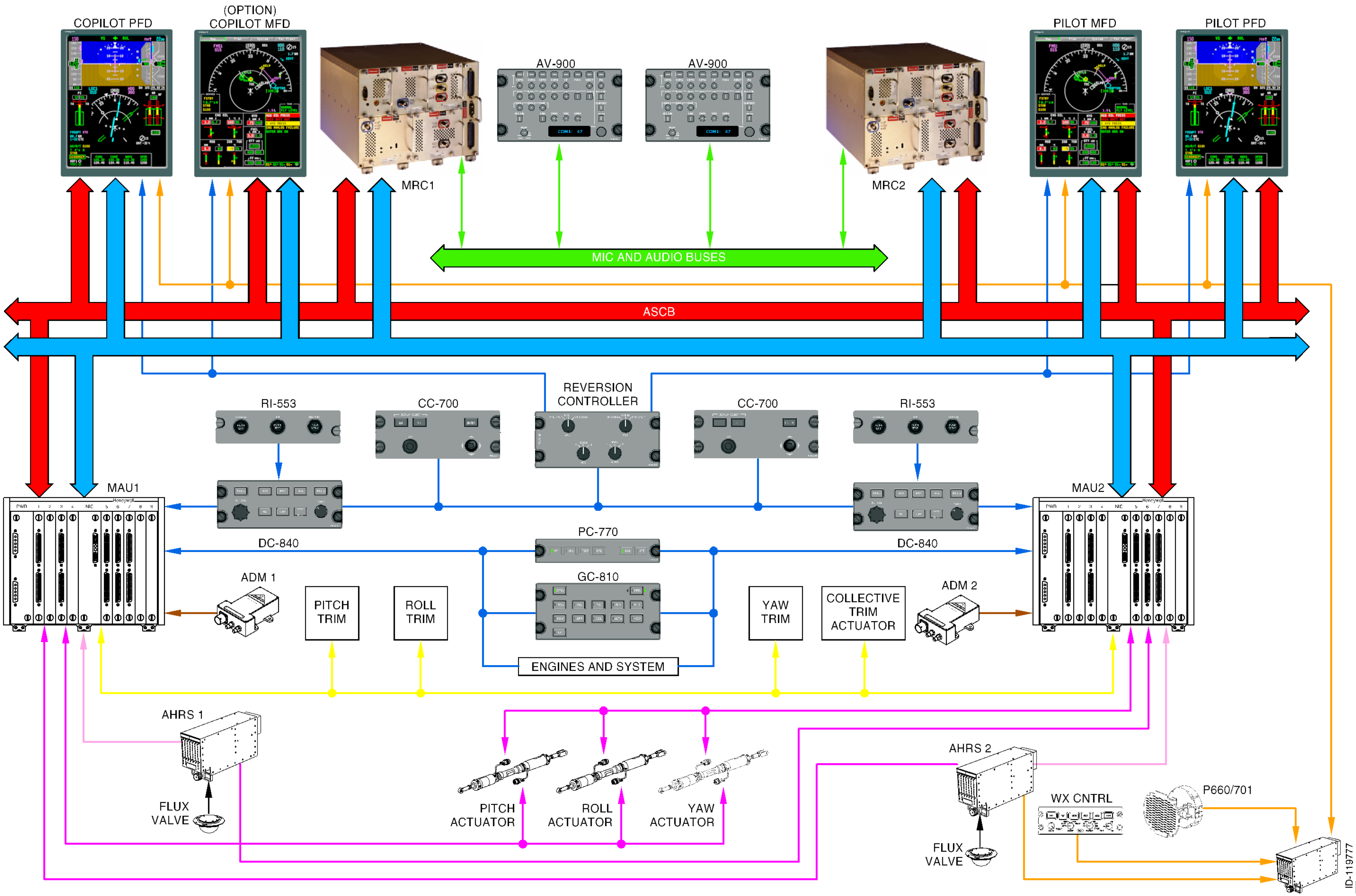


Figure 15-1
AHRS System Block Diagram

Heading information is generated with respect to the FOGs or the magnetic field of the earth, as determined by the pilot using the **MAG/DG** switch on the compass controller, shown in Figure 15-2. The information is displayed on the PFD, along with attitude, where it is used by the pilot for navigation and to maintain flight path direction.

True air speed (TAS) input from one or two external digital air data systems (DADS) is used to improve the attitude performance. In addition, AHRS is able to give inertial altitude and vertical speed if augmented by pressure altitude from one or two DADS. Utilizing data from the GPS receiver in combination with air data, gives additional output data such as ground speed for navigation applications.

CAUTION

THE AHRS DOES NOT COMPUTE HELICOPTER POSITION INFORMATION.

Each AHRS is made up of the following components:

- An attitude and heading reference unit (AHRU)
- A configuration memory module
- A flux valve
- A primary 28 V dc drive
- An auxiliary 28 V dc drive.

The AHRS interfaces with the following equipment:

- Flight guidance system (FGS)
- Flight management system (FMS) (Option)
- Air data computer (ADC)
- Electronic display system (EDS)
- Weather radar system.

Most modes of the AHRUs are effected depending on whether the helicopter is airborne or on the ground. The AHRU GND/AIR control switch connected to the helicopter weight-on-wheels (WOW) assembly tells the AHRUs whether the helicopter is airborne or on the ground.

The long-range heading reference is supplied by the magnetic sensor unit (MSU) of the flux valve assembly.

Attitude and Heading Reference Unit (AHRU)

The AHRU is the main electronic assembly of the AHRS. It contains the inertial sensor assembly, which include FOGs and micro-mechanical accelerometers.

Microprocessors in the AHRU compute flight parameters that are used for flight control and display functions. A memory module stores flux valve compensation data and aircraft AHRU orientation data.

Primary and auxiliary power for the AHRS is a 28 V dc. The AHRU power supplies receive dual input dc power from the aircraft. The AHRU supplies a 28 V dc for the flux valve.

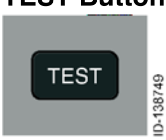
True airspeed (TAS) information is supplied by the air data modules (ADMs).

COMPASS CONTROLLER

The compass controller, shown in Figure 15-2, enables the pilot to control the operation of the AHRS.

Figure 15-2
Compass Controller

- **TEST Button** - The **TEST** button activates the system self-test.



- **COMPASS Annunciator** - The compass annunciator indicates a misalignment of the gyro-compass when the needle is not centered.

- **MAG/DG Switch** - With the **MAG/DG** switch in the **DG** position, the heading indicator is slaved to the directional gyros (FOGs). Placing the switch in the **MAG** position activates the MAG submode. This changes the heading indicator reference from being driven by the directional gyros to being referenced to local magnetic north.

- **SYNC Switch** – The **SYNC** switch is spring loaded. It is toggled in the direction indicated by the compass annunciator, either **+** or **-**, to align the gyro-compass.

AHRS MODES OF OPERATION

The operates in the following modes:

- Startup
- Alignment
- Operational
- MSU
- Self-test
- Maintenance.

Start-Up Mode

The start-up mode automatically initiates when power is applied to the the AHRS and performs the following.

- Performs power-on self-test.
- Initializes and starts inertial sensors.
- When the ambient temperature of the AHRS equipment is less than 15 °C or greater than 35 °C, a 25-second temperature stabilization phase stabilizes FOG temperatures to within the normal operating temperature range. This increases the total run up time by 25 seconds.
- Transitions immediately to the fast alignment phase if the system identifies a short power interrupt in its operational mode and if the aircraft motion does not exceed certain limits. No other start-up actions are performed in this case.

  When the fast alignment mode is initiated by the start-up mode, attitude and heading are realigned by the system based on the average aircraft motion at the time.
- Activates the maintenance mode when the system detects a maintenance mode trigger.
- Initiates shut-down when a flight critical failure is detected during self-test.
- Activates alignment mode phases 1 and 2.

The AHRS is operational when the the attitude and heading flags are removed from the PFD.

Alignment Mode

The alignment mode is initiated after the start-up mode is complete. The alignment sequence is an automated process that is completed when the two alignment phases described in the following paragraphs are performed consecutively without interruption.

After short power interruptions with a duration less than 500 milliseconds (±15%, due to component tolerances) the AHRS has the ability to perform a fast realignment cycle.

In the alignment mode, the attitude and heading alignment is performed with the heading alignment being derived from the magnetic sensing unit (MSU) unless the DG is selected. Pitch and roll angles are determined by the internal accelerometers.

During a static alignment, earth rate and gyro drift are estimated in order to improve the system accuracy. The estimation is performed independent of whether the AHRU is in DG or MAG submode. The estimated value of the vertical earth rate is stored in a nonvolatile memory and is used for the following power on initialization of the estimation procedure.

NOTES:

1. With the helicopter on the ground and angular motion not exceeding 1° for a period of 1 second or less, alignment is complete in 30 seconds with a tolerance of 5%. This process is referred to a static alignment.
2. Wind buffeting on the ground, cargo loading etc., is probably insufficient to induce a transition from static to moving alignment.
3. With the helicopter in flight or on the ground with angular motion not exceeding 5° for 2 seconds or less, 2 minutes is required to complete the alignment process. This process is referred to as a moving alignment.
4. Angular rates outside the envelopes described above extend the alignment time.

HEADING ALIGNMENT

Performing the heading alignment while airborne requires that the helicopter be maintained in straight and level flight.

When the DG submode is selected at the beginning of the alignment process, the initial heading is set to 360°.

ATTITUDE ALIGNMENT

In flight, the AHRS uses TAS from the ADM to perform attitude alignment. If TAS from the ADM is not available, the pilot must maintain the helicopter in straight and level flight for the system to successfully align the attitude.

When the alignment process is completed, the AHRS operational mode is activated.

ALIGNMENT PHASE 1

The alignment phase 1 automatically begins when start-up mode is complete. Alignment phase 1 takes place with the helicopter static or moving and requires 15 seconds to complete with an error tolerance of $\pm$5%.

Initially, pitch, roll, and heading indicate zero. Yaw, rate-of-turn and normal acceleration indications are set to zero. When alignment phase 1 is completed, alignment phase 2 is activated.

ALIGNMENT PHASE 2

Alignment phase 2 is initiated automatically after completion of the alignment phase 1. The time it takes to complete alignment phase 2 depends on how much motion the helicopter experiences during both alignment phases.

If the motion of the helicopter does not exceed the static alignment limits noted above, static alignment takes place. If the motion of the helicopter exceeds the static alignment limits noted above, moving alignment takes place.

In the case of moving alignment, different alignment criteria in the system can result in attitude alignment being completed before heading alignment is completed. When alignment phase 2 is complete, the AHRS automatically enters the operational mode.

Operational Mode

Operational mode commands the AHRS to continuously determine helicopter pitch and roll rates to supply attitude and heading information to the user systems. With the AHRS in the operational mode, shutdown automatically takes place if power is removed from the system or if any flight critical failure is detected. In addition, operational mode is deactivated when the MSU is calibrated manually.

NORMAL SUBMODE

The normal submode is a submode of operational mode. It is activated when the helicopter is a static condition or in flight when TAS from the ADM is available. In the normal submode, the AHRS determines aircraft attitude autonomously.

If the helicopter is in a static condition for up to 5 minutes, the static limits of the helicopter are exceeded, the AHRU switches to the basic submode.

BASIC SUBMODE

The basic submode is also a submode of the operational mode. It automatically activates in flight when TAS is lost or when the helicopter is on the ground experiencing motion while in a static condition.

MAG SUBMODE

Placing the **MAG**/**DG** switch on the compass controller in the **MAG** position changes the heading indicator from being driven by the FOGs to being referenced to local magnetic north by the flux valve.

A fast heading realignment takes place after changing from DG to MAG mode or when the slew function (slew left or slew right) is selected. No distinction is made between either of the slew inputs.

DG SUBMODE

Placing the **MAG**/**DG** switch on the compass controller in the **DG** position changes the heading indicator.

With the **MAG**/**DG** switch in the DG position, the aircraft heading can be set by using the slew function (such as, **SYNC** switch on the compass controller).

Magnetic Sensing Unit (MSU) Calibration Mode

MSU calibration mode is manually initiated by the MSU calibration control switch located at the front of the AHRU or by internal MSU calibration controls. The calibration control switch is mechanically locked to rule out accidental operation and disabled until alignment is complete or if the aircraft is inflight. The MSU calibration mode compensates for MSU errors of up to 12°.

Initially, the AHRS is switched automatically to DG submode, the attitude and heading warnings are displayed and the improper heading is indicated until the aircraft is moved. As soon as a turn is detected the corrected heading is displayed.

The calibrating calculations require the aircraft to be stationary in an initial position and turned clockwise in steps of 45° (±5°) around the vertical axis.

During each turn the heading warning flag displays. The aircraft must stand still in each position until the heading warning flag is removed indicating good information being sent to the heading indicator.

Data collecting is complete after turning through 315° (7 steps of 45°). The calibration is in an external detachable device located at the AHRU front plate. The heading warning flag is removed and the corrected heading is indicated.

Resetting the MSU calibration switch to OFF restores the AHRS to full operation or it is automatically terminated when the helicopter becomes airborne. The AHRS is fully restored to operational mode.

System Self-Test

The system self-test is initiated by pushing the **TEST** button on the compass controller. Self-test is disabled during start-up or shut-down and while in flight.

When the self-test is performed, the test output for parameters that can be observed are as follows:

- Pitch: +5°
- Roll: +45°
- Heading: +15°.

In addition to the canned attitude and heading data, an **ATT TEST** annunciator is displayed in the ADI and a **HDG TEST** annunciator is displayed in the compass.

Upon the completion of the self-test, the AHRS returns to normal operation after a delay of about 1 second.

If the self-test is in operation when the helicopter becomes airborne, it is automatically terminated.

Invalid AHRS Data

A loss of valid pitch or roll information from the AHRS is indicated on the PFD by the removal of the pitch tape, roll pointer, and flight director bars. The entire **attitude sphere** is displayed in cyan and an **ATT FAIL** is displayed in the top of the attitude sphere when the data is invalid. If the loss of data is due to AHRS test, **ATT TEST** is displayed instead of **ATT FAIL**.

Maintenance Modes

The maintenance modes are a function of maintenance activity and supplied for use by maintenance personnel.

Shut Down Mode

AHRS shut-down is automatic when power to the AHRU drops below a threshold of 12 V dc. The AHRS shuts down automatically when any flight critical failure is detected.

With the AHRU in the operational mode, motion data is stored so a fast realignment can be performed in the event of a power interruption.

When shut-down initiates as a result of a temporary DC power loss, the AHRU goes idle. It becomes operational when the input power increases 12 V dc.

When shut-down is initiated by a failure condition, the AHRU automatically shuts down the power supply. A restart of the AHRS is performed when power is restored and the system is recycled by manually switching the power OFF and ON again.

Baro-Inertial Loop

Vertical velocity and altitude are computed in a third order baro inertial loop. The loop is dampened by the barometric altitude input. Velocity and altitude output are only valid, if valid altitude input is available. Input can be invalid for up to 5 seconds.

The time constant of the loop is 30 seconds with a damping ratio of 1.0 in normal mode. In basic mode, the time constant is 15 seconds and the loop is reduced to second order.

Limitations on Aerobatic Flights

As the AHRS gives magnetic heading derived from the MSU, the MSU data is reliable as a reference in straight and level flight conditions only. During aerobatic flight profiles the platform heading and the platform attitude are in free inertial operation, influencing the AHRU heading and the possible attitude accuracy due to the gyro drift.

To maintain the specified system accuracy, it is necessary to fly the aircraft straight and level for a period of 60 seconds after a maximum of 20 minutes of aerobatic flight.

AHRS OUTPUTS

Version 1105 AHRS offers two independent ARINC 429 outputs that give the following minimum parameters:

- Magnetic sensor input
- Body normal acceleration
- System time
- MSU field strength
- MSU calibration error
- Magnetic heading
- Pitch angle
- Roll angle
- Body pitch rate
- body roll rate
- Body yaw rate
- Body longitudinal acceleration
- body lateral acceleration
- Body normal acceleration
- Magnetic sensor input
- Pitch attitude rate
- Roll attitude rate
- Inertial altitude
- Vertical acceleration
- Inertial vertical speed
- Along heading acceleration
- Cross heading acceleration
- Mode of the AHRS

- Validity of the AHRS
- Software version of the AHRS.

Version 1115 AHRS gives the following additional parameters:

- True heading
- Track angle true
- Magnetic variation
- Groundspeed
- Present position latitude
- Present position longitude
- Latitude fine
- Longitude fine
- Flight path angle
- NS velocity true
- EW velocity true
- Wind speed
- Wind direction true
- Track angle magnetic
- Drift angle
- Flight path acceleration
- Track angle rate
- Along heading velocity
- Across heading velocity
- Wind direction magnetic
- NS velocity magnetic
- EW velocity magnetic.

16. PRIMUS EPIC 660/700/701 Digital Weather Radar System

INTRODUCTION

The PRIMUS EPIC 660 and 700/701 digital weather radar systems are a lightweight, X-band digital radar with alphanumerics designed for weather (WX) detection and ground mapping (GMAP). In addition, the 700/701 Digital Weather Radar gives the pilot high resolution ground mapping.

The purpose of the systems are to detect storms along the flight path and give the pilot a visual color indication of rainfall intensity. In addition, the 700/701 Digital Weather Radar gives the pilot turbulence content. After proper evaluation, the pilot can chart a course to avoid storm areas.

This section gives a brief summary of the systems operations. A detailed description of the Weather Radar System functions are described in the PRIMUS 660 Weather Radar System, Honeywell Pub. No. A28-1146-111 and the PRIMUS 700/701 Weather Radar System, Honeywell Pub. No. 28-1146-66.

PRIMUS EPIC 660 DESCRIPTION

The PRIMUS EPIC 660 digital weather radar system, shown in Figure 16-1, shows weather in the MAP page of the multifunction display and can be shown on the primary flight display super-imposed under the HSI graphics. The WX radar consists of the following components:

- Weather radar receiver transmitter antenna (RTA)
- Weather radar controller.

NOTE: Two radar controllers can be installed.

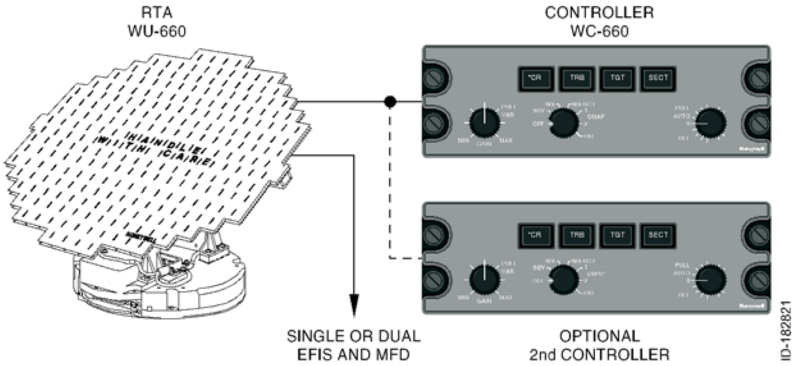


Figure 16-1
PRIMUS EPIC 660 Digital Weather Radar System Configurations

To aid in target interpretation, storm intensity levels of the WX mode are displayed in the bright colors listed below. These colors are contrasted against a deep **black** background. The intensity levels correspond to the National Weather Service (NWS) video integrated processor (VIP) levels.

Each color represents an area of progressively stronger returns.

- **Black** – Intensity Level 0 – Little or no rainfall
- **Green** – Intensity Level 1 – Moderate rainfall
- **Yellow** – Intensity Level 2 – Less severe rainfall
- **Red** – Intensity Level 3 – Heavy rainfall
- **Magenta** – Intensity Level 4 – Areas of very heavy rainfall
- **White** – Areas of detected turbulence.

Radar signals reflected from ground surfaces are displayed in the following colors, ranging from most reflective to least reflective.

- **Magenta** – Most reflective ground surface return
- **Yellow** – Moderately reflective ground surface return
- **Cyan** – Least reflective ground surface return.

The system configuration uses an RTA and dual controllers. Radar information is displayed on the MFD in the map mode.

Weather on the MFD

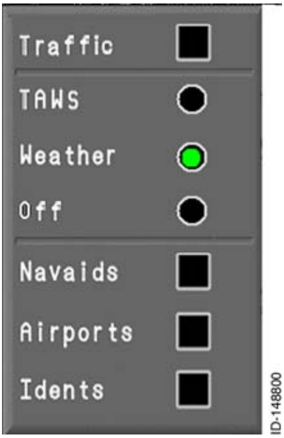
Range marks and identifying numerics displayed on the MFD in contrasting colors are used to evaluate the location of storm cells relative to the aircraft, as shown in Figure 16-2.

Figure 16-2
Weather Displayed on the MFD

MFD WEATHER STATUS WINDOW

When the weather radar is turned ON, the weather sensor status window is displayed in the lower left corner of the main MFD window when the MAP page is selected, as shown in Figure 16-3. The window is identified by the header WEATHER.

Figure 16-3
Weather Status Window



Weather is displayed on the MFD by selecting the exclusive Weather menu item on the MFD pull-down menu or pushing the **WX/TERR** button on the display controller. A green dot ( ) is placed in the circle adjacent to Weather to indicate that it has been selected for display.

The WX mode annunciators are displayed on the top line of the WEATHER window. The mode annunciators are white when they are not selected for display, green when selected for display, and amber when flashing. FSTBY and FAIL are always amber when they are displayed.

The mode annunciators for the P-660 are: WAIT, STBY, FSTBY, TEST, WX (when selected for display), WX (when not selected for display), WX (when failed), WX/T, WX/RCT, WX/R/T, GMAP, FPLN, and FAIL.

The mode annunciators for the P-700/701 are: WAIT, STBY, FSTBY, TEST, WX (when selected for display), WX (when not selected for display), WX (when failed), WX/T, WX/RCT, WX/R/T WX/GCR, GMP1, GMP2, GMP1/SCR, GMP1/CR1, GMP1/CR2, ROC, BCN, and FAIL.

The WX mode annunciators toggle reverse video when any of the following conditions are met:

- The WX mode is WAIT.
- For the P-660 radar, a transmitting mode is active (TEST, WX, WX/T, WX/RCT, WX/GCR, or GMAP) and the aircraft is on the ground.
- For the P-700/701 radar, a transmitting mode is active (TEST, WX, WX/T, WX/RCT, WX/R/T, WX/GCR, GMP1, GMP2, GMP1/SCR, GMP1/CR1, GMP1/CR2, or ROC) and the aircraft is on the ground.

The WAIT, FSTBY, and STBY annunciators have priority over all other modes in the order listed and only one can be active at any one time.

Weather radar antenna tilt setting data is displayed on the second line of the WX mode annunciators. The tilt data is displayed to a .5° resolution for tilt angles between ±10° and to a 1° resolution for angles ±10°. The data is preceded by a green T. The data is followed with an arrow that points up for positive angles and points down for negative angles (such as, T7.5↑ for seven and a half tilt up). The data is followed with an A label when the autotilt function is active (such as, T7.5↑ A).

The target alert mode annunciator and the variable gain indicator is displayed on the third line of the window. Only one annunciator can be displayed at a time with the target alert mode annunciator having priority over the variable gain indicator. When target alert mode is selected, a **TGT** annunciator is displayed. When the radar detects an alert condition, the **TGT** toggles to **TGT** and back for as long as the condition exists. Variable gain indication is displayed as a digital readout of knob rotation when the variable gain mode has been selected. The indication is in the format of **G 75%** . For example, gain is at 75%. Full counterclockwise position of the knob corresponds to 0% and full clockwise position of the knob corresponds to 100%.

NOTE: The P-700 radar variable gain indication is displayed with a **VGN** annunciation.

The following mode selection combinations are restricted:

- Variable gain cannot be active with ground clutter reduction (GCR), rain compensation technique (RCT), or target alert (TGT).
- GCR, RCT, and TGT have priority over variable gain.
- RCT cannot be active with GCR. GCR has priority over RCT.
- GCR cannot be active with turbulence. Turbulence has priority over GCR.
- Turbulence, RCT, or TGT cannot be active with GMAP. GMAP has priority over turbulence.
- GCR or turbulence cannot be active in ranges > 50 NM and TGT cannot be active in ranges > 300 NM.
- The P-700/701 GCR can be activated with turbulence mode. GCR has priority over turbulence.

NOTE: The P-660 radar does not support turbulence, references to turbulence addresses installation of the P-700/701 radar.

When the radar stabilization is OFF, an amber **STAB** annunciator is on the third line directly below the target alert/variable gain line.

When an internal weather radar failure occurs, the mode annunciator on the first line is replaced with an amber **FAIL** annunciator. When the radar is indicated ON and the serial bus is inactive, the mode annunciator changes to an amber **WX**. When the range is commanded by the CCD and the WX does not respond with the requested range, the **range value** is annunciated in amber for 5 seconds before returning to the previous range setting. A weather radar bus failure is annunciated with an amber **WX** on the MFD range ring.

PFD WEATHER RADAR

Weather radar returns can be overlaid on the HSI with or without FMS map display when the compass display is in arc mode and weather radar returns have been selected for display by the display controller.

On the PFD, weather can only be displayed in the HSI arc mode, as shown in Figure 16-4. When the weather radar is turned ON, the weather sensor status window is displayed in the lower left corner of the HSI section of the PFD.

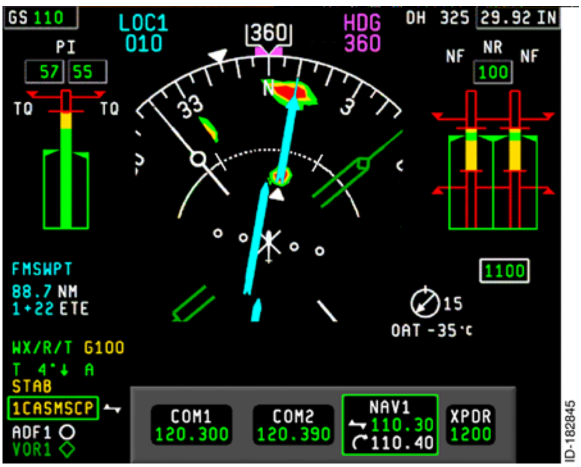


Figure 16-4
Weather Displayed on the PFD

The display of weather scans across the arc mode and is selected on the display controller using the **WX/TERR** button.

- **WX/TERR (Weather Radar/Terrain) Control Button** - Pushing the **WX/TERR** button toggles the HSI display in the following sequence:

☞ **WX/TAWS OFF** ☞ **ARC/WX** ☞ **ARC/TERR** ☞ **ARC**

Like the **MAP** button, pushing the **WX/TERR** button automatically selects the arc mode for the HSI.

NOTE: When WX or TAWS is not installed but is selected, the **NO WX/TAWS INSTAL** CAS message is displayed for 5 seconds. **NO WX/TAWS INSTAL** is displayed when the **WX/TERR** button is pushed when weather radar or TAWS is installed but the function is not available for display on the PFD.

- **Weather Mode Annunciators Window** – Weather radar (WX) annunciators are displayed below the RNP display in the lower left corner of the HSI section of the PFD when the radar returns are selected for display or when weight is on wheels and a transmit mode is active (all weather radar modes except standby). The mode annunciators and operations are identical to the MFD annunciators described previously.

ID-148792

- **Transmit Annunciator** – When the aircraft is on the ground and a transmitting mode is active, the TX annunciator toggles amber reverse video (TX) regardless of the display selection.

- **Target Alert** – When target alert mode is selected and a radar target is detected, an amber TGT annunciator is displayed. The alert toggles amber reverse video (TGT) for 5 seconds when a target is first detected. The TGT annunciator lights steadily as long as the alert condition exists. The annunciator is active in both full or arc mode.

- **Sector Scan** – The weather radar normally scans a range of ±60° referenced to current heading. The PFD arc mode only supports display of ±45° around the current heading as the WX display is limited to this range as well. When the WX system is operating in the sector scan mode, left and right tick mark positions are on the 50% scale arc. This indicates that the sector mode of the radar has been selected and highlights the limits of the radar scan.

- **WX Failure** – When the serial bus is inactive, the mode annunciator is replaced with an amber WX annunciator.

WEATHER (WX) RADAR CONTROLLER - 660

Controls and display features of the P-660 WX radar controller are shown in Figure 16-5. Lighting for all legends and controls on the indicator are controlled by the aircraft panel.

Figure 16-5
Weather Radar Controller

Single or dual controls can be used. When a single controller is used, all weather radar displays show the same radar data. When dual controllers are used, weather radar displays are controlled by the controller for that side. Either controller can be slaved to the other for identical radar displays throughout the radar system, as shown in Table 16-1.

Table 16-1
Dual Control Mode Truth Table

Left Controller Mode	Right Controller Mode	Left Side (Note 1)	Right Side (Note 1)	RTA Mode
OFF	OFF	OFF	OFF	OFF
OFF	STBY	SLV STBY	STBY	STBY
STBY	OFF	STBY	SLV STBY	STBY
OFF	ON	SLV ON	ON	ON
ON	OFF	ON	(SLV) ON	ON
STBY	ON	STBY/2	ON/2	ON
ON	STBY	ON/2	STBY/2	ON

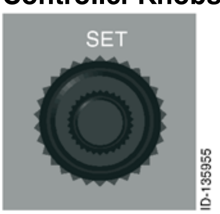
Table 16-1 (cont)
Dual Control Mode Truth Table

Left Controller Mode	Right Controller Mode	Left Side (Note 1)	Right Side (Note 1)	RTA Mode
ON	ON	ON/2	ON/2	ON
STBY	STBY	STBY	STBY	STBY

NOTES:
1. ON is used to indicate any selected radar mode.
2. SLV means that displayed data is controlled by opposite side controller.
3. XXX/2 means that display is controlled by the on-side control for the antenna sweep direction associated with that control. (/2 implies two controllers are on.)
4. In standby, RTA antenna is centered on the azimuth with 15° upward tilt. Video data is suppressed. The transmitter is inhibited.
5. The multifunction display (MFD) repeats left-side data.

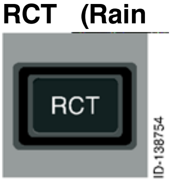
Controller Switches and Controls

- **Controller Knobs –** The concentric knobs on the CCD are used to set the operating radar range. WX ranges can be set from five to 300 NM (nautical miles) full scale. In the flight plan (FP) mode, ranges of 500 and 1000 miles can be set. One-half the selected range is annunciated at the one-half scale range mark on the display.



NOTE: For dual controller installations, the weather radar range is controlled by the on-side weather radar controller.

- **RCT (Rain Echo Attenuation Compensation Technique) Button** – The **RCT** button is used to select the RCT mode. The RCT mode compensates for attenuation of the radar signal as it passes through rainfall. The cyan field indicates areas where further compensation is not possible. Any target detected within the cyan field cannot be calibrated and must be considered severe weather. All targets in the cyan field are displayed in magenta for fourth level precipitation.



Selecting RCT forces the system to preset gain. When RCT is selected, the RCT legend is displayed.

- **STAB (Stabilizer) Button** – Pushing the **STAB** button engages or disengages the stabilization function that automatically compensates for aircraft roll and pitch maneuvers.

ID-138756

Some controllers annunciate OFF when stabilization is OFF.

- **TGT (Target) Button** – The **TGT** button engages or disengages the radar target alert feature. Target alert can be selected out to the 300–mile range. When selected, target alert monitors beyond the selected range and 7.5° on each side of the aircraft heading. When a return with certain characteristics are detected in the monitored area, the target alert changes from the TGT armed annunciator to the TGT warning annunciator, as shown in Table 16–2, for target alert characteristics. The target advises the pilot of a potentially hazardous condition directly in front of and outside of the selected range. When this warning is received,the pilot must select longer ranges to view the target. Target alert is inactive within the selected range.

ID-138755

Selecting target alert forces the system into the preset gain condition. Target alert can be selected in the WX and FP modes.

Table 16–2
Target Alert Characteristics

Selected Range (NM)	Target Depth (NM)	Target Range (NM)
5	5	5–55
10	5	10–60
25	5	25–75
50	5	50–100
100	5	100–150
200	5	200–250
300	N/A	N/A
FP (Flight Plan)	5	5–55

- **SECT (Sector) Button** – Pushing the **SECT** button toggles the system between the normal 12 looks/minute 120° scan and the faster update, 24 looks/minute 60° sector scan.

ID-138757

- **TILT Knob** – The rotary **TILT** knob is used to set the tilt angle of the antenna beam with relation to the aircrafts longitudinal axis. Turning the knob clockwise (cw) tilts the beam upward to +15°, turning the knob counterclockwise (ccw) tilts the beam downward to -15°.

ID-138758

A digital readout of the antenna tilt angle is annunciated on the display.

WARNING

TO AVOID FLYING UNDER OR OVER STORMS, FREQUENTLY SELECT MANUAL TILT TO SCAN BOTH ABOVE AND BELOW THE AIRCRAFT. ALWAYS USE MANUAL TILT FOR WEATHER ANALYSIS.

- **LSS (Lightning Sensor System) (Option)**

The lightning sensor system (LSS) is an option that can be installed along with the P-660 WX radar. It is operated by the MFD MAP pull-down menu. Reference Section 17, Lightning Sensor System, for a detailed description of LSS operation.

- **SLV (Slave) (Dual Installations Only)**

The **SLV** annunciator is used in dual controllers. With dual controllers, one controller can be slaved to the other by selecting OFF on that controller with the **RADAR** mode switch. This slaved condition is annunciated with the **SLV** annunciator. The slave mode permits one controller to set the modes of the RTA for both sweep directions. In the slave mode, all EFIS WX displays are identical and updated on each sweep.

With dual controllers, both controllers must be OFF before the radar system turns OFF.

- **RADAR Knob** – The **RADAR** (mode) knob is a rotary knob used to select one of the following functions:

  — **OFF** – In the OFF position, the radar system is OFF. **WX** is displayed in the mode field.

  — **SBY (Standby)** – In the SBY position the radar system is placed in standby, a ready state, with the antenna scan stopped. The transmitter is inhibited and the display memory is erased. SBY is displayed in the mode field.

  Selecting SBY before the end of the warm-up period (approximately 45 seconds), results in WAIT being displayed in the mode field.

  When the warm-up period is over, the system automatically switches to the STBY mode.

  — **FSBY (Forced Standby)** – FSBY mode is an automatic safety feature. It is controlled by the weight-on-wheels (WOW) switch and stops the radar transmitter from emitting X-band microwave radiation on the ground.

  In the FSBY mode, the transmitter and antenna scan are both inhibited, the memory is erased, and FSBY is displayed in the mode field.

  When in FSBY mode, pushing the STAB button four times within three seconds overrides the FSBY mode.

NOTE: When weather radar is displayed on the MFD, FSBY is dropped once the aircraft is airborne.

  — **WX (Weather)** – Selecting WX places the radar system in the weather direction mode. The system is fully operational and all internal parameters are set for en route weather detection.

  When **WX** is selected before the end of the initial RTA warm-up period (approximately 45 seconds), WAIT is displayed.

In the wait mode, the transmitter and antenna scan are inhibited and the memory is erased.

When the warm-up period is over, the system automatically switches to WX mode and **WX** is displayed in the mode field.

In preset gain, the system is calibrated, as listed in Table 16-3.

Table 16-3
Rainfall Rate Color Cross Reference

Color	Rainfall Rate (inches/hr)	Rainfall Rate (mm/hr)
Green	.04-.16	1-4
Yellow	.16-.47	4-12
Red	.47-2	12-50
Magenta	Greater than 2	Greater than 50
Cyan	react mode	
Dim White	Turbulence	

— **GMAP** - GMAP places the radar system in the ground mapping mode. GMAP sets the system to enhance returns from ground targets. RCT compensation is inactive.

NOTE: Weather targets are not calibrated when the radar is in GMAP mode. GMAP mode must not be used for weather detection.

When GMAP is selected, **GMAP** is displayed and the color scheme is changed to **cyan**, **yellow**, and **magenta**. Cyan represents the **least** reflective return, yellow is a **moderate** return, and magenta is a **strong** return.

When GMAP is selected before the end of the initial RTA warm-up period (approximately 45 seconds), **WAIT** is displayed.

In the wait mode, the transmitter and antenna scan are inhibited and the memory is erased.

When the warm-up period is over, the system automatically switches to GMAP mode and **GMAP** is displayed in the mode field.

NOTE: The system only performs weather detection and ground mapping. Do not rely upon it for ground proximity warning or anticollision protection.

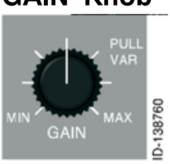
— **Flight Plan (FP)** - In the FP position, the WX transmitter is placed on standby and the map range is selected up 1000 NM. The flight plan data from the selected FMS is displayed. Weather and lightning sensor system (when selected for display) underlays the flight plan data.

NOTE: When weather is not selected for display, the MFD has its own range control.

— **TST** - The TEST position selects the radar test mode. A special test pattern is displayed to verify system operation. **TEST** is displayed in the mode field.

NOTE: When the aircraft is on the ground and forced standby (FSBY) is overridden, the radar transmitter is on and emitting x-band microwave energy in the test mode. Refer to the maximum permissible exposure level (MPEL) in this chapter.

- **GAIN Knob** - The **GAIN** control knob controls receiver gain. Variable gain is used for additional weather analysis and for ground mapping.



ID-138760

Pushing the **GAIN** control knob activates the radar in the preset, calibrated gain mode. Calibrated gain mode is the normal mode for weather avoidance.

In calibrated gain, the **GAIN** control knob cannot be turned. Pulling the **GAIN** control knob activates the variable gain mode.

In the WX mode, variable gain can increase receiver sensitivity over the calibrated level to show very weak targets or it can be reduced below the calibrated level to eliminate weak returns.

WARNING

HAZARDOUS TARGETS ARE REMOVED FROM THE DISPLAY WITH LOW VARIABLE GAIN SETTINGS.

Variable gain reduces the level of strong returns from ground targets.

Minimum gain is set when the knob is in the fully counter-clockwise (ccw) position.

Gain increases as the knob is turned cw from fully ccw position to the 12 o'clock position. At the 12 o'clock position, both the gain and the sensitivity time control (STC) are at maximum levels. Additional cw rotation removes STC.

At the full cw position, gain is at maximum and the STC is at minimum.

STC reduces receiver gain at the start of the trace, increasing it as more distant returns are received. With STC, a uniform display of cell strength is displayed for both near and distant cells.

The variable legend (G) annunciates variable gain. Selecting RCT, or TGT forces the system into preset gain. Preset gain is not annunciated.

PRIMUS EPIC 700/701 DESCRIPTION

The PRIMUS EPIC 700/701 digital weather radar system shows weather and beacon information in the MAP page of the multifunction display and can be shown on the primary flight display super-imposed under the HSI graphics. The WX radar consists of the following components, as shown in Figure 16-6.

- Weather radar receiver/transmitter (RT)
- Antenna pedestal
- Antenna flat plate radiator
- Weather radar controller
- Beacon controller.

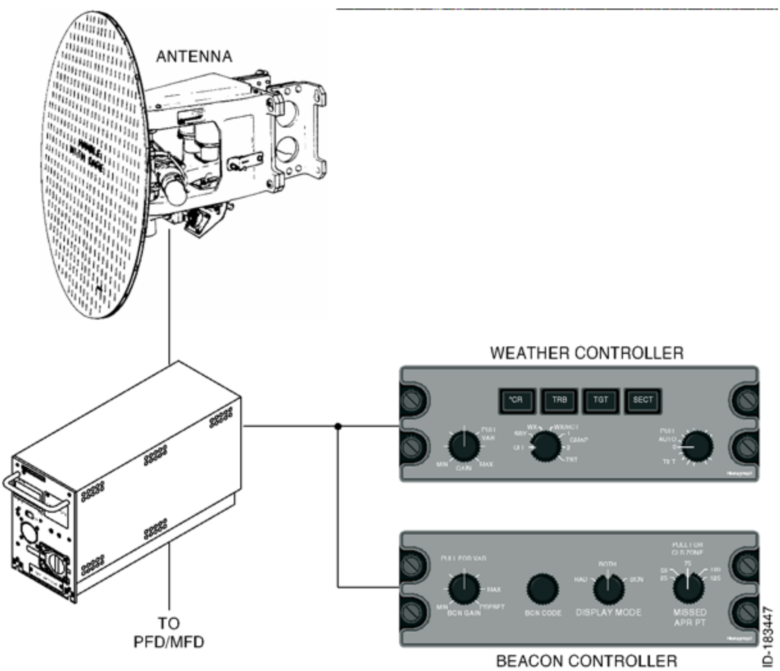


Figure 16-6
PRIMUS EPIC 700/701 Digital Weather Radar System Configurations

NOTE: The following paragraphs describe the characteristics of the PRIMUS EPIC 700/701 that are not described previously for the PRIMUS EPIC 660 Weather Radar.

Weather Radar Controller WC 700

Controls and display features of the P-700 WX radar controller are shown in Figure 16-7. Lighting for all legends and controls on the indicator are controlled by the aircraft panel.

Figure 16-7
Weather Radar Controller

Single or dual controls can be used. When a single controller is used, all weather radar displays show the same radar data. When dual controllers are used, weather radar displays are controlled by the controller for that side or either controller can be slaved to the other for identical radar displays throughout the radar system, as shown in Table 16-4.

Table 16-4
Dual Control Mode Truth Table 700 Series

Left Controller Mode	Right Controller Mode	Left Side (Note 1)	Right Side (Note 1)	RTA Mode
OFF	OFF	OFF	OFF	OFF
OFF	STBY	SLV STBY	STBY	STBY
STBY	OFF	STBY	SLV STBY	STBY
OFF	ON	SLV ON	ON	ON
ON	OFF	ON	(SLV) ON	ON
STBY	ON	STBY	ON	ON
ON	STBY	ON	STBY	ON

Table 16-4 (cont)
Dual Control Mode Truth Table 700 Series

Left Controller Mode	Right Controller Mode	Left Side (Note 1)	Right Side (Note 1)	RTA Mode
ON	ON	ON/2	ON/2	ON
STBY	STBY	STBY	STBY	STBY

NOTES:
1. ON is used to indicate any selected radar mode.
2. SLV means that displayed data is controlled by opposite side controller.
3. XXX/2 means that display is controlled by the on-side control for the antenna sweep direction associated with that control. (/2 implies two controllers are on.)
4. In standby, RTA antenna is centered on the azimuth with 15° upward tilt. Video data is suppressed. The transmitter is inhibited.
5. The multifunction display (MFD) repeats left-side data.

Controller Switches and Controls

- **Concentric Knobs** – The concentric knobs on the CCD are used to set the operating radar range. Full scale range selections of 0.5, 1.0, 2.5, 5.0, 10, 25, 50, 100, 200, and 300 NM are available. One-half the selected range is annunciated at the one-half scale range mark on the display.

ID-135955

Simultaneously pushing both range switches overrides forced standby mode.

NOTE: For dual controller installations, the weather radar range is controlled by the on-side weather radar controller.

- ***CR (Clutter Reduction) Button** – The ***CR** button is used to select ground clutter reduction (GCR) in the weather modes or either of the two sea clutter reduction (SCR) techniques (CR1 or CR2) in the GMAP 1 mode.

ID-184645

Ground clutter reduction is an advisory mode that reduces the display of ground clutter. Targets remaining on the display are very likely weather targets.

The system automatically exits the GCR mode 10 seconds after the last push of the ***CR** button when in any weather mode.

Clutter reduction is available on the 50-mile range or less and is not available in GMAP 2.

WARNING

1. **EVEN THOUGH GCR REMOVES GROUND TARGETS FROM THE DISPLAY, THE GROUND IS STILL PRESENT, IT IS SIMPLY NOT BEING DISPLAYED.**
2. **GCR REMOVES MOST OF THE GROUND TARGETS FROM THE DISPLAY BUT, AT THE SAME TIME, IT REMOVES A PERCENTAGE OF THE WEATHER.**

- The GCR has the following limitations:
  - It does not remove all of the ground and it does remove some of the weather.
  - It is most effective dead ahead and its effectivity is reduced as the antenna scans away from dead ahead.
  - The circuitry assumes reasonable tilt settings (looking down 15 degrees and turning on the GCR does not eliminate the ground return) for proper operation.

  Selecting the 100, 200, or the 300 NM range turns OFF the ground clutter reduction. The GCR legend is deleted from the mode annunciator.

- **GMAP 1** – Successive pushes of the ***CR** button results in the selection to toggle from CR 1 to CR 2 to none. CR 1 uses pulse pair Doppler processing and CR 2 uses fast time constant processing. The use of variable gain in conjunction with sea clutter reduction can be required for best results.

NOTE: It is highly recommended that the operator become familiar with sea clutter reduction techniques on clear days.

- **GMAP 2** – Selecting GMAP 2 turns OFF sea clutter reduction.

- **TRB (Turbulence) Button**– The **TRB** button is used to select the turbulence detection mode of operation. The TRB mode can only be selected in the WX or WX/RCT position and the selected range is 50 miles or less. The weather/turbulence mode is annunciated in the mode field with the **WX/T** legend. Areas of moderate or greater turbulence threshold is nominally 5 meters per second.

CAUTION

TURBULENCE CAN ONLY BE DETECTED WITHIN AREAS OF RAINFALL. RADAR CANNOT DETECT CLEAR AIR TURBULENCE. UNDETECTED TURBULENCE MAY EXIST WITHIN ANY STORM CELL.

— Selecting the 100, 200, or the 300 NM range turns OFF the turbulence detection. The /T is deleted from the mode annunciator. Subsequent selection of ranges of 50 miles or less reengages turbulence detection.

NOTE: As an EFIS installation option, the areas of turbulence can be wired to blink between white and black.

- **TGT Button** – The **TGT** button is used to enable and disable the radar target alert feature. Target alert is selectable in the 5 to 200 mile ranges. When selected, target alert monitors 50 miles beyond the selected range and 7.5 degrees on each side of the aircraft heading. If a red or magenta return with target alert characteristics are detected in the monitored area, the target alert legend changes from the green TGT condition to the amber TGT warning condition. The pilot is advised of a potentially hazardous targets directly in front of the aircraft outside the selected range. Upon receiving the amber warning, the pilot must select longer ranges to view the questionable target. The target alert is inactive within the selected range.

ID-138755

Selecting target alert forces the system to preset gain. Target alert can be selected only in the WX or WX/RCT modes.

- **TILT Knob** – The rotary **TILT** knob is used to set the tilt angle of the antenna beam with relation to the aircrafts longitudinal axis. Turning the knob clockwise (cw) tilts the beam upward to +15°, turning the knob counterclockwise (ccw) tilts the beam downward to –15°.

ID-138758

A digital readout of the antenna tilt angle is displayed on the CRT.

Some controllers have a pull for autotilt function. Pulling out on this control engages the radar autotilt feature. In radar autotilt, the antenna tilt is automatically adjusted with regard to the selected range and barometric altitude. The antenna tilt automatically readjusts with changes in altitude and/or selected range. In radar autotilt, the tilt control can fine tune the automatic tilt setting by ±2 degrees.

Radar autotilt is annunciated with a green **A** following the digital tilt readout. The digital tilt readout always shows the commanded tilt of the antenna regardless of the source of the tilt command (autotilt command or manual tilt command).

NOTE: The radar autotilt is adjusted to display a few ground targets at full range, but at long ranges, ground clutter is displayed at somewhat less than the maximum display range. This is due to the earths curvature and the lower the aircraft altitude, the more pronounced this situation becomes.

- **SLV** – It is an annunciator that lights when the controller does not have control of the radar.

- **RADAR** – The **RADAR** (mode) switch is a rotary switch used to select one of the following functions:

— **OFF** – The system is turned OFF. In addition, in installations with dual WC–700 controllers, selecting OFF on one slaves the display to the opposite side controller. Selecting OFF on both controllers turns the system OFF.

NOTE: If any of the following modes are selected prior to completion of the warm–up period, **WAIT** is displayed in the mode field.

— **SBY** – In this mode, the radar is kept in the ready state. The antenna does not scan, the transmitter is disabled, display memory is erased, and the antenna is centered. Useful during taxiing, loading, etc. **STBY** is displayed in the mode field. In dual control operations, if only one controller is in standby, the transmitter is transmitting.

WARNING

TRANSMITTER OUTPUT POWER IS RADIATED IN THE FOLLOWING MODES OF OPERATION.

— **WX** – This selects the weather detection operation. WX is displayed in the mode field.

— **WX/RCT** – This selects the weather mode with activation of the REACT function. GCR or TURB can be selected to operate with REACT. **WX/RCT** is displayed in the mode field. REACT disables variable gain.

In preset gain, the system is calibrated, as listed in Table 16-5.

RCT is available in the WX mode only and selecting RCT forces the system to preset gain. When engaged, the RCT legend is displayed in the REACT field. REACT functions can be switched ON and OFF with the **RCT** button.

CAUTION

WEATHER TYPE TARGETS ARE NOT CALIBRATED WHEN THE RADAR IS IN THE GMAP MODE. BECAUSE OF THIS, THE PILOT SHOULD NOT USE THE GMAP MODE FOR WEATHER DETECTION.

— **GMAP 1** - The color thresholds are set for maximum sensitivity to detect small targets in the water. The pulse width is set for maximum resolution to permit good definition between adjacent range targets. GMAP 1 is most useful in sea-search applications. GMP 1 is displayed in the mode field.

— **GMAP 2** - The color thresholds and pulse width are set for good terrain mapping operation. GMP 2 is displayed in the mode field.

The use of variable gain can be required to obtain the optimum search or mapping performance in specific circumstances.

It is recommended that the operator become familiar with both GMAP modes and WX (used for mapping) on clear days.

NOTE: As a constant reminder that GMAP is selected, the color scheme is changed to cyan, yellow, and magenta. Cyan represents the least reflective return, yellow is a moderate return, and magenta is a strong return.

— **TST** - This selects a special test pattern for system verification. TEST is displayed in the mode field.

WARNING

THE TRANSMITTER IS ON AND RADIATING X-BAND MICROWAVE ENERGY IN THE TEST MODE.

NORMAL OPERATION

Tilt Management

Figures 16-8 and 16-9 show the relationship between tilt angle, flight altitude, and selected range. The figures show the distance above and below aircraft altitude that is lit by the flat-plate radiator during level flight with 0° tilt and shows a representative low altitude situation with antenna adjusted for 2.8° up-tilt.

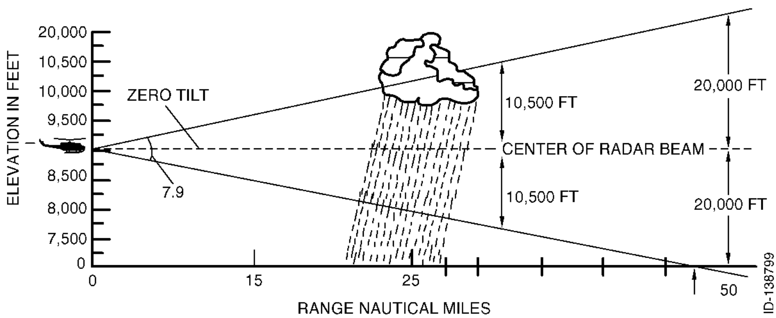


Figure 16-8
Radar Beam Illumination High Altitude
12-Inch Radiator

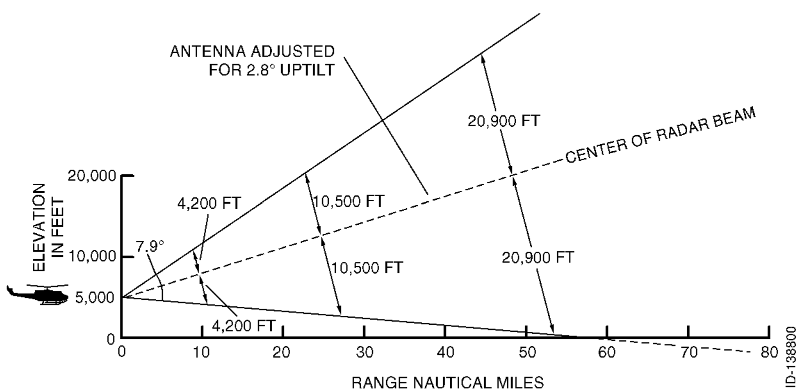


Figure 16-9
Radar Beam Illumination Low Altitude
12-Inch Radiator

PRELIMINARY CONTROL SETTINGS

Before powering up the helicopter electrical system, place the **RADAR** control (mode), **GAIN** control, and **TILT** control, in the following positions.

BRT/OFF	**Off (On WI-700)**
MODE control:	**Off (On WC-700)**
GAIN control:	**Preset Position**
TILT control:	**+15**

WARNINGS

1. **AVOID OPERATING THE RADAR WHILE ON THE GROUND IN ANY MODE OTHER THAN STANDBY.**
2. **WHEN OPERATING THE RADAR ON THE GROUND IN ANY OTHER MODE THAN STANDBY IS NECESSARY, POSITION THE HELICOPTER SO THE SCAN SECTOR OF THE RADAR IS A MINIMUM OF 100 FEET FROM ANY LARGE METALLIC OBJECTS SUCH AS HANGARS OR OTHER AIRCRAFT.**
3. **DO NOT OPERATE THE RADAR DURING HELICOPTER REFUELING OPERATIONS OR WITHIN 100 FEET OF OTHER AIRCRAFT BEING REFUELED.**
4. **DO NOT OPERATE THE RADAR WITH GROUND PERSONNEL STANDING TOO CLOSE TO OR WITHIN THE 270° FORWARD SECTOR OF HELICOPTER. (REFER TO MPEL LATER IN THIS SECTION.)**
5. **OPERATING PERSONNEL SHOULD BE FAMILIAR WITH FAA AC 20-68B, REFERENCED IN HONEYWELL PUB. NO. 28-1146-120.**

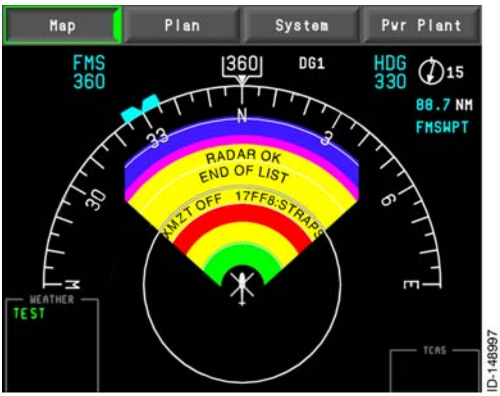
Power-Up Procedure

Table 16-5 lists the power-up procedure for the PRIMUS EPIC 660/700/701 digital weather radar system.

Table 16-5
PRIMUS Power-Up Procedure

Step	Procedure
1	Verify that the system controls are in the positions described below before powering up the radar system. BRT/OFF: **Off (On - WI-700)** Mode control: **Off (On - WC-700)** GAIN control: **Preset Position** TILT control: **+15**
2	Take the following precautions when the radar system is operated in any mode other than standby or forced standby while the aircraft is on the ground: • Direct the nose of the aircraft so that the antenna scan sector is free of large metallic objects, such as hangars or other aircraft for a minimum distance of 100 ft (30 meters) and tilt the antenna fully upwards. • Do not operate the radar system during aircraft refueling or during refueling operations within 100 ft (30 meters). • Do not operate the radar when personnel are standing too close to the 120° forward sector of aircraft. (Refer to Maximum Permissible Exposure Level later in this section.)
3	When the system is being used with an EFIS display, power-up by selecting the weather display on the EHSI. Apply power to the radar system using either the indicator or controller power controls.
4	Select standby or test mode.
5	When power is first applied, the radar is in **wait** for approximately 90 seconds to enable the magnetron to warm up. Power interruptions lasting less than 3 seconds result in a 6-second wait period. **NOTE:** When forced standby is incorporated, it is necessary to exit forced standby.

Table 16-5 (cont)
PRIMUS Power-Up Procedure

Step	Procedure
6	After the warm-up, select the test (TST) mode and verify that the test pattern is displayed, as shown in Figure 16-10. **NOTE:** The API (a strap option) paints and unpaints on alternate sweeps to supply a continuous indication of picture bus activity. The color of the text does not change on alternate sweeps.  **Figure 16-10** **WX Test Pattern**
7	Verify that the azimuth marks, target alert (TGT), and sector scan controls are operational.

Standby

When standby is selected, the antenna is stowed in a tilt-up position and is neither scanning nor transmitting. Standby must be selected when the pilot wants to keep power applied to the radar without transmitting.

Radar Mode - Weather

For purposes of weather avoidance, pilots should familiarize themselves with FAA Advisory Circular AC 00-24B (1-20-83). Subject: Thunderstorms.

To help the pilot categorize storms as described in the advisory circular referenced above, the radar receiver gain is calibrated in the WX mode with the GAIN control in the preset position. The radar is not calibrated when variable gain is being used but calibration is restored when **RCT** or **TGT** is selected.

Targets are displayed in various colors. Each color represents a specific target intensity.

In the WX mode, the system shows five levels of intensity as **black**, **green** , **yellow** , **red** , and **magenta** in increasing order of intensity.

When RCT is active, the radar receiver adjusts calibration automatically to compensate for attenuation losses, as the radar pulse passes through weather targets on its way to light other targets.

There is a maximum to which calibration can be adjusted. When the maximum is reached, REACT (rain echo attenuation compensation technique) compensation ceases. At this point, a cyan **field** is added to the display indicating no further compensation is possible.

In the absence of intervening targets, the range at which the cyan **field** starts is approximately 290 NM with a 12-inch antenna. For the 18-inch antenna, the cyan **field** starts beyond 300 NM and therefore, is not seen if there are no intervening targets.

RCT compensates for rain attenuation (spreading out or weakening) of the radar pulse.

When RCT is actively compensating for rain attenuation, color calibration changes to maintain calibration regardless of the amount of rain attenuation. When this happens, calibration can no longer keep the radar system calibrated for red level **targets** .

The heavier the rainfall, the greater the attenuation and the shorter the range the radar can identify targets. Therefore, the range at which the cyan **background** starts varies depending on the amount of attenuation. The greater the attenuation, the closer the start of the cyan **field** .

The radar calibration includes an allowance for loss of pieces of the radome due to ice accumulation, water, etc. Excessive losses in the radome seriously affects radar calibration. One means of verification are signal returns from known targets. Honeywell recommends that the pilot report evidence of weak returns to ensure that radome performance is maintained at a level that does not affect radar calibration.

Target alert can be selected in any WX range. Target alert monitors for hazardous targets within ±7.5° of the aircraft centerline.

Radar Mode – Ground Mapping

Ground mapping operation is selected by setting the controls to GMAP. The **TILT** control is turned down until a usable amount of navigable terrain is displayed. The degree of down-tilt depends on the aircraft altitude and the selected range.

The receiver sensitivity time control (STC) characteristics are altered to equalize ground-target reflection versus range. As a result, selecting preset gain creates the desired mapping display. However, the pilot can control the gain manually (by selecting manual gain and rotating the GAIN control) to help achieve an optimum display.

With experience, the pilot can interpret the color display patterns that indicate water regions, coast lines, hilly or mountainous regions, cities, or even large structures. A good learning method is to practice ground-mapping during flights in clear visibility where the radar display can be visually compared with the terrain.

Test Mode

The PRIMUS EPIC 660 digital weather radar Ssstem has a self-test mode and a maintenance function.

In the self-test mode, a special test pattern is displayed as illustrated earlier in this section. The functions of this pattern are as follows:

- **Color Bands** - A series of **green** / **yellow** / **red** / **cyan** / **white** / **magenta** / **blue** /**black** bands indicate that the signal to color conversion circuits are operating normally.

  The maintenance function lets the pilot or the line maintenance technician determine the major fault areas. The fault data can be displayed in one of two ways (selected at the time of installation):

  — TEXT FAULT - A plain English text indicating the failure is placed in the test band

  — FAULT CODE - A fault code is displayed, refer to the maintenance manual for an explanation.

The indicator or CAS Message display indicates a fault as noted in the following paragraph.

- **MFD/PFD** - Faults are shown when test is selected.

  NOTES:

  1. Some weather failures on DUs are annunciated with an amber **WX**.

  2. Some EFIS installations can power-up with an amber **WX** annunciator when weather radar is turned OFF.

  3. When the fault code option is selected, they are shown with the FAIL annunciator (for example, FAIL 13).

IN-FLIGHT ADJUSTMENTS

Pitch and Roll Trim Adjustments

The PRIMUS EPIC 660/700/701 digital weather radar system is delivered from the Honeywell factory or repair facility adjusted for correct pitch and roll stabilization. However, due to the tolerances of some vertical reference sources, make a final adjustment when the radar or vertical reference is replaced on the aircraft or when stabilization problems are observed in flight.

The four trim adjustments and their effects are listed in Table 16-6.

Table 16-6
Pitch and Roll Trim Adjustments Criteria

Trim Adjustment	Flight Condition	Effect On Ground Return Display (Over Level Terrain)
Roll offset	Straight and level	Nonsymmetrical display.
Pitch offset	Straight and level	Ground displays do not follow contour of range arcs.
Roll gain	Constant roll angle >20°	Nonsymmetrical display.
Pitch gain	Constant pitch angle >5°	Ground displays do not follow contour of range arcs.
NOTE: Generally, it is recommended to perform trim adjustments only if noticeable effects are being observed.		

NOTES:

1. Depending on the installation, not all of the adjustments listed in Table 16-7 are available. When STAB TRIM ENABLE programming pin is open, only the roll offset adjustment is available. When STAB TRIM ENABLE programming pin is grounded, all four adjustments are available. Consult the installation configuration information for details.

2. After any adjustment procedure is completed, monitor the ground returns displayed by the radar during several pitch and roll maneuvers. Verify that the ground returns stay somewhat constant during changes in aircraft orientations. If not, repeat the adjustment procedure.

3. After the trim adjustment feature is selected, more than one adjustment can be made. They are available in the sequence shown in Table 16-7, and can be done by completing one adjustment and proceeding to the next by pushing the **STAB** button.

4. The in-flight stabilization adjustment range is limited. When a satisfactory adjustment in-flight cannot be achieved, a ground adjustment is required.

5. Proper radar stabilization depends on the accuracy and stability of the installed attitude source.

6. The procedure of the **STAB** button pushed assumes the use of a controller, not an indicator. When using an indicator, pulling the **TILT** knob out or pushing it in is equal to pushing the **STAB** button on a controller.

7. When the in-flight stabilization procedures are finished, the STAB can be OFF (STAB light on). An additional push of the button is required to turn the STAB back on.

Level Flight Stabilization Check

Follow the procedures in Table 16-7 to determine when there is a need to perform the roll offset adjustment.

Table 16-7
Stabilization in Straight and Level Flight Check Procedure

Step	Procedure
1	Trim the aircraft for straight and level flight in smooth, clear air over level terrain at an altitude of at least 10,000 ft AGL.
2	Select the 50-mile range and GMAP mode.
3	Adjust the tilt control until the radar display shows a solid band of ground returns starting at the 40-mile range arc.
4	After several antenna sweeps, verify that ground returns follow the range arc closely and are equally displayed on both sides, as shown in Figure 16-11. When the ground returns are not equally displayed on both sides, (as shown in Figure 16-12 and Figure 16-13), perform the roll offset adjustment listed in Table 16-8.

NOTE: A condition where the strongest ground targets move from side to side over a period of several minutes can be the result of the gyro erection circuits chasing a slow wingwalk in the flight path. Roll offset adjustment cannot compensate for this condition.

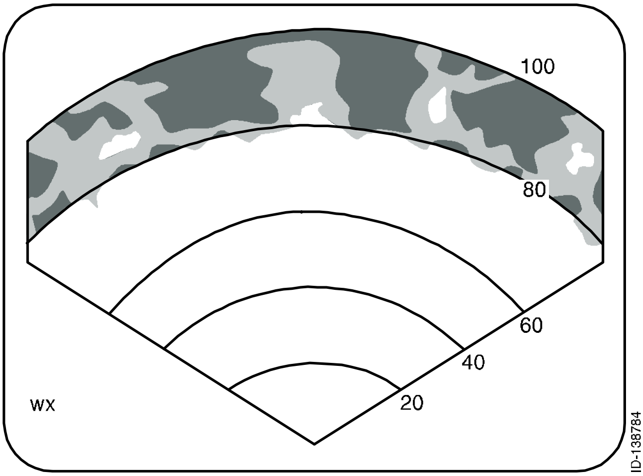


Figure 16-11
Symmetrical Ground Returns

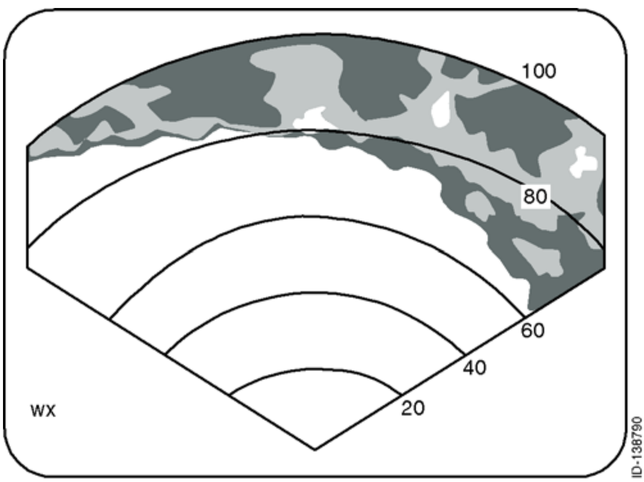


Figure 16-12
Ground Return Indicating Misalignment (Right)

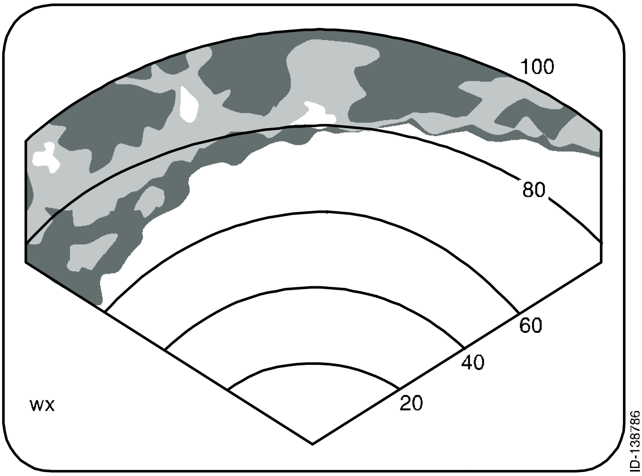


Figure 16-13
Ground Return Indicating Misalignment (Left)

ROLL OFFSET ADJUSTMENT

An in-flight adjustment can be made when level flight stabilization errors are detected. This procedure is done by the WC-660 weather radar controller. During this procedure, listed in Table 16-8, the **GAIN** control acts as roll offset control. After the procedure, the **GAIN** control reverts to acting as a gain control.

Table 16-8
In-Flight Roll Offset Adjustment Procedure

Step	Procedure
1	When two controllers are installed, one must be turned OFF. When an indicator is used as the controller, the procedure is the same as given below.
2	Fly to an altitude of 10,000 ft AGL or greater.
3	Set range to 50 NM.
4	Adjust the tilt down until a solid band of ground returns are shown on the screen. Adjust the tilt until the green **region** of the ground returns start at about 40 NM.

Table 16-8 (cont)
In-Flight Roll Offset Adjustment Procedure

Step	Procedure
5	Select **STAB** (**STB)** four times within three seconds. A display with text instructions is displayed, as shown in Figure 16-14. The radar unit is in the roll offset adjustment mode.
6	Pull out the **GAIN** knob to make a roll offset adjustment. A typical display is shown in Figure 16-15. The offset range is from -2.0° to +2.0° and is adjustable by the **GAIN** knob. The polarity of the **GAIN** knob is such that clockwise rotation of the knob results in the antenna moving down when scanning on the right side.
7	While flying straight and level, adjust the **GAIN** knob until ground clutter display is symmetrical.
8	Push in the **GAIN** knob. When the **GAIN** knob is pushed in, the display returns to the previous message.
9	Push the **STAB** (**STB**) button to exit, or to go to the next menu (pitch offset), when the full **STAB** trim mode is enabled in installation.
NOTE: Once set, the roll compensation is stored in nonvolatile memory in the RTA. It is retained when the system is powered down.	

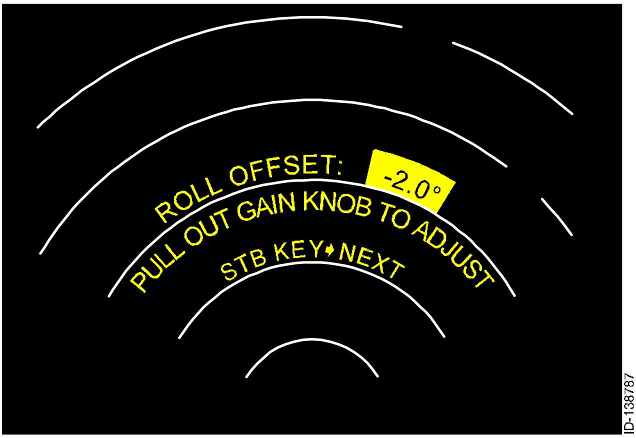


Figure 16-14
Roll Offset Adjustment Display - Initial

Figure 16-15
Roll Offset Adjustment Display - Final

PITCH OFFSET ADJUSTMENT

This in-flight adjustment is made in straight and level flight when the ground returns do not follow the contours of the radar display range arcs. The procedures are listed in Table 16-9.

Table 16-9
Pitch Offset Adjustment Procedure

Step	Procedure
1	When two controllers are installed, one must be turned OFF. When an indicator is used, the procedure is the same as given below.
2	Fly to an altitude of 10,000 feet AGL or greater.
3	Set range to 50 NM.
4	Adjust the tilt down until a solid band of ground returns are shown on the screen. Adjust the tilt until the green **region** of the ground returns start at about 40 NM.
5	Select **STAB** (**STB**) four times within three seconds. The roll offset display is shown.
6	From the roll offset entry menu, push the **STAB** (**STB**) button once more to bring up the pitch offset entry menu.
7	To change the pitch offset value, pull out the **GAIN** knob and rotate it. The offset range is from −2.0° to +2.0°.
8	When flying straight and level, adjust so the contour of the ground returns follow the contour of the range arcs as closely as possible.
9	When change is completed, push in the **GAIN** knob. The display returns to the previous message.
10	Push the **STAB** (**STB**) button to go to the next menu (roll gain).

ROLL STABILIZATION CHECK

Once proper operation in level flight has been established, verify correct roll stabilization using the procedures listed in Table 16-10.

Table 16-10
Roll Stabilization (While Turning) Check Procedure

Step	Procedure
1	Trim the aircraft for straight and level flight in smooth, clear air over level terrain at an altitude of at least 10,000 ft AGL.
2	Select the 50-mile range and **GMAP** mode.
3	Adjust the **TILT** control until the radar display shows a solid band of ground returns starting at the 40-mile range arc, as shown in Figure 16-16.
4	Place the aircraft in a 20° (or greater) roll to the right. When there is little change to the arc of ground returns, the roll stabilization is good.
5	When ground returns come in closer on the right side and go out on the left side, the roll is understabilized, as shown in Figure 16-17.
6	When the ground returns go out on the right side and come in closer on the left side, the roll is overstabilized, as shown in Figure 16-18.
7	When the roll is understabilized or overstabilized, perform an in-flight roll gain adjustment, as listed in Table 16-11.

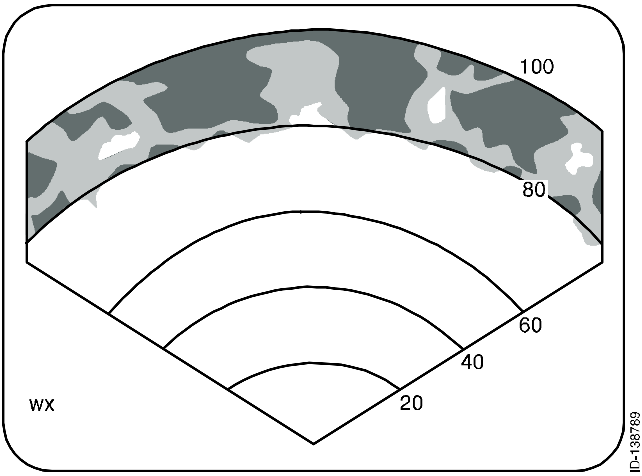


Figure 16-16
Symmetrical Ground Returns,
Level Flight and Good Roll Stabilization

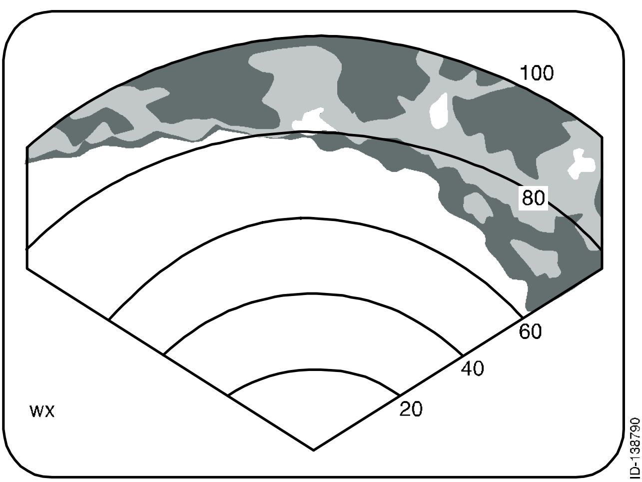


Figure 16-17
Understabilization in a Right Roll

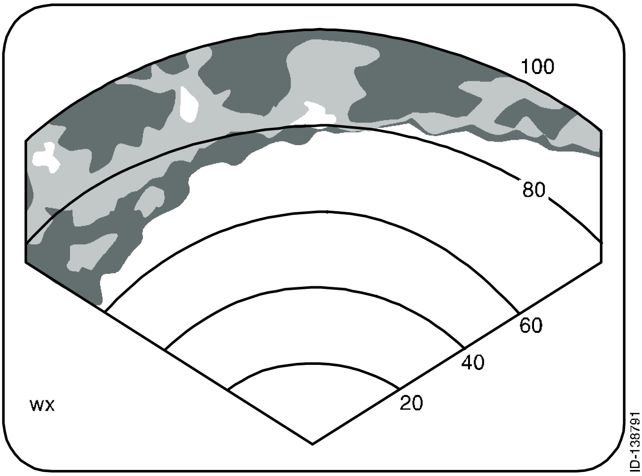


Figure 16-18
Overstabilization in a Right Roll

ROLL GAIN ADJUSTMENT

This in-flight adjustment is made in a bank when the ground returns do not remain symmetrical during turns. These procedures are listed in Table 16-11.

Table 16-11
Roll Gain Adjustment Procedure

Step	Procedure
1	When two controllers are installed, one must be turned OFF. When an indicator is used as the controller, the procedure is the same as given below.
2	Fly to an altitude of 10,000 ft AGL or greater.
3	Set range to 50 NM.
4	Adjust the tilt down until a solid band of ground returns are shown on the screen. Adjust the tilt until the green **region** of the ground returns start at about 40 NM.
5	Select **STAB** (**STB**) four times within three seconds. A display with text instructions for roll offset is shown.
6	From the roll offset entry menu, push the **STAB** (**STB**) button two more times to bring up the roll gain entry menu.
7	To change the roll gain value, pull out the **GAIN** knob and rotate it. The roll gain adjustment range is from 90 to 110%.
8	While flying with a steady roll angle of at least 20°, adjust for symmetrical display of ground returns at the 40-NM range arc.
9	When change is completed, push in the **GAIN** knob. The display returns to the previous message.
10	Push the **STAB** (**STB**) button to go to the next menu (pitch gain).

PITCH STABILIZATION CHECK

This in-flight adjustment is made in a bank when the ground returns do not remain symmetrical during turns. These procedures are listed in Table 16-12.

Table 16-12
Pitch Stabilization Check Procedure

Step	Procedure
1	Trim the aircraft for straight and level flight in smooth, clear air over level terrain at an altitude of at least 10,000 ft AGL.
2	Select the 50-mile range and **GMAP** mode.
3	Adjust the **TILT** control until the radar display shows a solid band of ground returns starting at the 40-mile range arc, as shown in Figure 16-19.
4	Place the aircraft between 5° and 10° pitch up. When there is little change to the arc of ground returns, the pitch stabilization is good.
5	When the display of ground returns goes out of range, the pitch is understabilized, as shown in Figure 16-20.
6	When the display of ground returns comes in closer in range, the pitch is overstabilized, as shown in Figure 16-21.
7	When the pitch is understabilized or overstabilized, perform an in-flight pitch gain adjustment, as listed in Table 16-12.

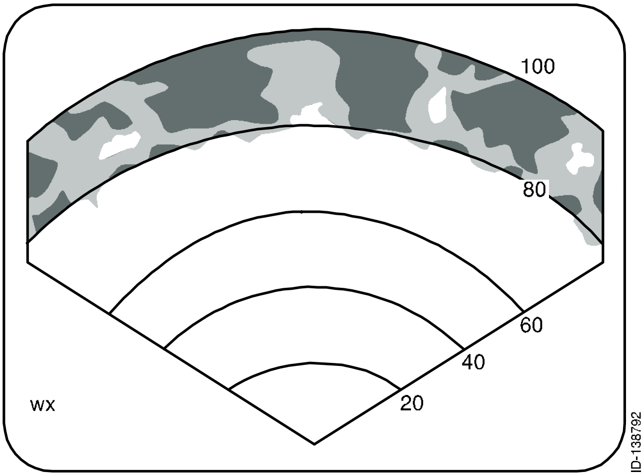


Figure 16-19
Level Flight and Good Pitch Stabilization

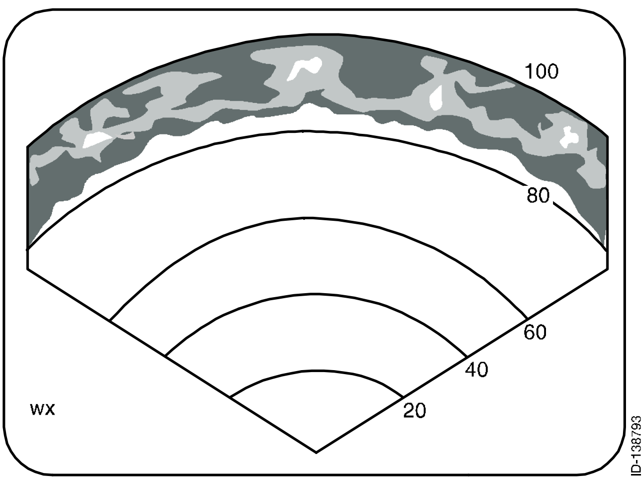


Figure 16-20
Understabilized in Pitch Up

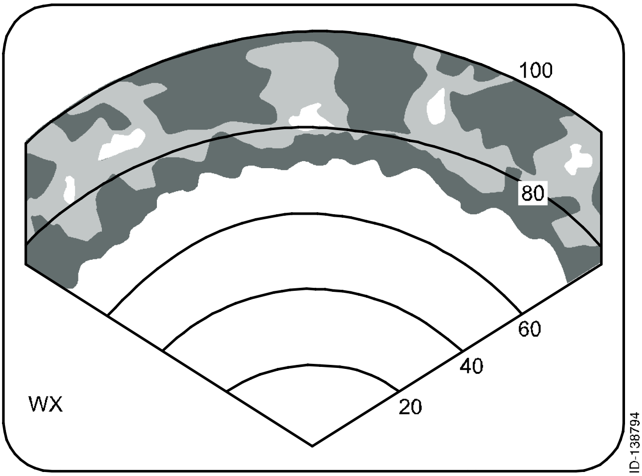


Figure 16-21
Overstabilized in Pitch-Up

PITCH GAIN ADJUSTMENT

This in-flight adjustment is made in a bank when the ground returns do not follow the contours of the range arcs during turns. These procedures are listed in Table 16-13.

Table 16-13
Pitch Gain Adjustment Procedure

Step	Procedure
1	When two controllers are installed, one must be turned OFF. When an indicator is used as the controller, the procedure is the same as given below.
2	Fly to an altitude of 10,000 ft AGL or greater.
3	Set range to 50 NM.
4	Adjust the tilt down until a solid band of ground returns are shown on the screen. Adjust the tilt until the green **region** of the ground returns start at about 40 NM.
5	Push **STAB** (**STB**) four times within three seconds. A display with text instruction is shown.
6	From the roll offset entry menu, push the **STAB** (**STB**) button three more times to bring up the pitch gain entry menu.
7	To change the pitch gain value, pull out the **GAIN** knob and rotate it. The pitch gain adjustment range is from 90 to 110%.
8	While flying with a steady pitch angle of > 5°, adjust so the contour of the ground returns follow the contour of the range arcs as closely as possible.
9	When change is completed, push in the **GAIN** knob. The display returns to the previous message.
10	Push the **STAB** button to exit the mode and save the value in nonvolatile memory.

TEST MODE WITH TEXT FAULTS ENABLED

When airborne, if the radar is switched to test mode, any current faults are displayed.

When on the ground (weight-on-wheels active) and the radar is switched to test mode, any current faults are displayed followed by up to 32 faults from the last 10 power-on cycles. The historic faults are displayed going from the most recent to the oldest and are cycled every two antenna sweeps (approximately 8 seconds). The POC number indicates how many power-on counts back into the history as to when the fault occurred. After the last fault, an END OF LIST message is displayed. To recycle through the list again, exit and re-enter the test mode.

Table 16-14 lists the six fault data fields that are displayed in Figure 16-22.

Table 16-14
Fault Data Fields

Field No.	Description
1	Pilot message
2	Line maintenance message
3	Fault code/power-on count
4	Fault name
5	Transmit ON/OFF
6	Strap code

NOTES:
1. When airborne, only fault fields 1, 2, and 3 are displayed.
2. Airborne, only the current faults are displayed.
3. Strap codes indicate the configuration that was done at the time of installation. Refer to the System Description and Installation Manual for further explanation.

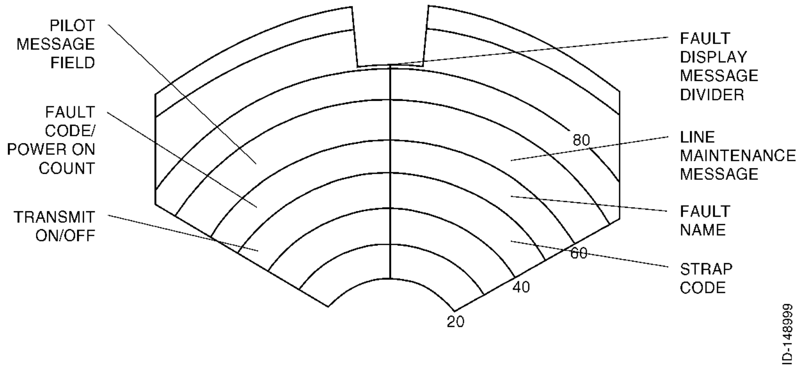


Figure 16-22
Fault Annunciator on Weather Indicator
With TEXT FAULT Fields

Figure 16-23 shows the fault codes displayed with the aircraft on the ground. Figure 16-24 shows a correctly completed test screen.

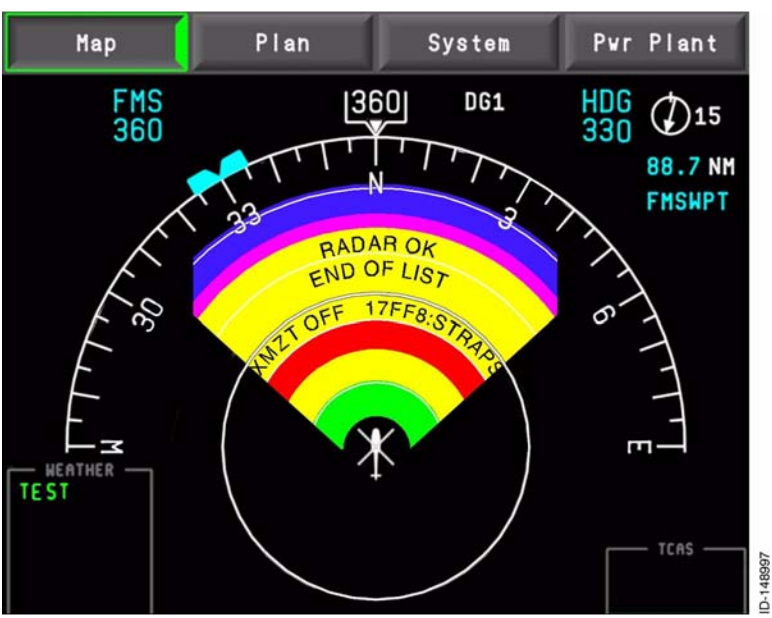


Figure 16-23
Radar Indicator With Text
Fault Enabled (on Ground)

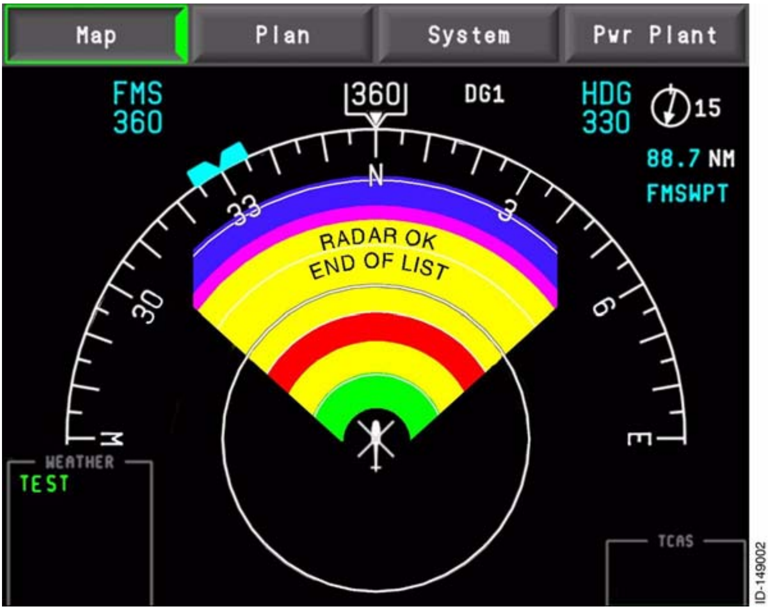


Figure 16-24
Successfully Completed WX Test Screen

PILOT EVENT MARKER

At any time, a full set of BITE parameters can be recorded by going in and out of variable gain four times (pull **GAIN** knob for VAR, push for preset, pull for VAR, and push for preset) within three seconds. There is no annunciator on the display after this operation.

This feature can be useful when the radar appears to be malfunctioning and a fail annunciator is not shown on the display. When the pilot event marker is used, it is best to record several sets of data during the period of misoperation. Refer to the PRIMUS 660 System Description and Installation Manual, Honeywell Pub. No. A09-3944-001 for information on constructing an interconnect cable for accessing this information.

FAULT CODE AND TEXT FAULT RELATIONSHIPS

Table 16-15 lists the relationship between:

- Fault codes (FC)
- Pilot/maintenance (MAINT) messages
- Fault name/type/description/cross reference (XREF).

Table 16-15 (Sheet 1 of 3)
Text Faults

FC	XREF	FAULT DESCRIPTION	FAULT NAME	PILOT MSG	LINE MAINT	FAULT TYPE
01	4808	Start-Up Code CRC	FLASH CRC	RADAR FAIL	PULL RTA	POWER ON
	4809	IOP Code CRC				
	4810	DSP Code CRC				
	4904	CONFIG Table CRC				
	4905	FPGA Firmware CRC				
02	4846	2V ADC Reference	IOP	RADAR FAIL	PULL RTA	CONTINUOUS
	4903	IOP Ready				POWER ON
	4908	INT ARINC 429 Loopback				
	4910	Spurious ARINC Interrupt	IOP	RADAR FAIL	PULL RTA	CONTINUOUS
	4913	ARINC 429 INT Coupling	IOP			POWER ON
03	4806	EEPROM Timer CRC	FLASH CRC	RADAR FAIL	PULL RTA	POWER ON
	4811	EEPROM POC	EEPROM			POWER ON
	4842	STAB Trim CRC		REDO STAB TRIM	REDO STAB TRIM	POWER ON
	4912	Calibration CRC	IOP	RADAR FAIL	PULL RTA	
04	4812	IOP Mailbox	MAILBOX RAM	RADAR FAIL	PULL RTA	POWER ON
	4818	DSP Mailbox				
05	4813	Timing FPGA RAM	FPGA	RADAR FAIL	PULL RTA	POWER ON
	4814	Timing FPGA REG				
	4815	I/O FPGA RAM				
	4828	FPGA Download				
	4906	I/O FPGA REG				

Table 16-15 (Sheet 2 of 3)
Text Faults

FC	XREF	FAULT DESCRIPTION	FAULT NAME	PILOT MSG	LINE MAINT	FAULT TYPE
06	4847	STC Monitor	STC DAC	RADAR FAIL	PULL RTA	POWER ON
07	4830	HVPS Monitor	HVPS MON	RADAR FAIL	PULL RTA	CONTINUOUS
10	4816	DSP RAM	DSP	RADAR FAIL	PULL RTA	POWER ON
	4817	DSP Video RAM				
	4855	DSP Watchdog				CONTINUOUS
	4900	Mailbox Miscompare				POWER ON
	4901	DSP HOLDA Asserted				
	4902	DSP HOLDA Not Asserted				
11	4825	Filament Monitor	MAGNETRON	RADAR FAIL	PULL RTA	LATCHED
	4827	Severe Magnetron				
	4829	PFN Trim Monitor	HVPS MON			CONTINUOUS
12	4831	Pulse Width	PULSE WIDTH	RADAR UNCAL	PULL RTA	CONTINUOUS
13	4832	Elevation Error	EL POSITION	TILT UNCAL	CHK RADOME/RTA	CONTINUOUS
14	4833	Azimuth Error	AZ POSITION	AZIMUTH UNCAL	CHK RADOME/RTA	CONTINUOUS
15	4836	Over TEMP	OVER-TEMP	RADAR CAUTION	PULL RTA	CONTINUOUS
16	4837	XMITTER Power	XMTR POWER	RADAR UNCAL	PULL RTA	CONTINUOUS
20	4839	No SCI Control	NO CNTL IN	CHK CNTL SRC	CHK CNTL SRC	PROBE
	4911	No ARINC 429 Control				

Table 16-15 (Sheet 3 of 3)
Text Faults

FC	XREF	FAULT DESCRIPTION	FAULT NAME	PILOT MSG	LINE MAINT	FAULT TYPE
21	4840	AGC Limiting		PICTURE UNCAL	PULL RTA	CONTINUOUS
	4927	AGC RX DAC Monitor		RADAR FAIL		POWER ON
	4928	AGC TX DAC Monitor	AGC			
22	4841	Selftest OSC Failure	RCVR SELF-TEST	PICTURE UNCAL	PULL RTA	CONTINUOUS
24	4843	Multiple AFC Unlocks	AFC	SPOKING LIKELY	PULL RTA	CONTINUOUS
	4845	AFC Sweeping				
	4929	AFC RX DAC Monitor		RADAR FAIL		POWER ON
	4930	AFC Trim DAC Monitor				
27	4848	AHRS/IRS Source	NO STAB SRC	STAB UNCAL	CHK ATT SRC	INSTALLATION
	4852	Analog STAB REF				
34	4853	Scan Switch Off	SCAN SWITCH	SCAN SWITCH	CHK SWITCH	INSTALLATION
35	4854	XMIT Switch Off	XMIT SWITCH	XMIT SWITCH	CHK SWITCH	INSTALLATION
36	4914	Invalid Altitude/Airspeed/STAB Strapping	INVALID STRAPS	RADAR UNCAL	CHK STRAPS	POWER ON
	4915	Invalid Controller Source Strapping				
	4916	Config1 Database Version/Size Mismatch	IOP	RADAR FAIL	PULL RTA	

Table 16-16 lists the pilot messages.

Table 16-16
Pilot Messages

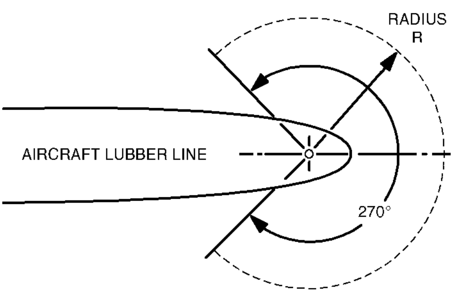
Pilot MSG	Description
RADAR FAIL	The radar is currently inoperable and must not be relied upon. It needs to be replaced or repaired at the next opportunity.
RADAR CAUTION	A failure has been detected that can compromise the calibration accuracy of the radar. Information from the radar must be used only for advisory purposes such as ground mapping for navigation.
PICTURE UNCAL	The radar functions are OK, but receiver calibration is degraded. Color level calibration is incorrect. Have the RTA checked at the next opportunity.
TILT UNCAL	An error in the antenna position system has been detected. The displayed tilt angle setting could be incorrect. This can also result in ground spoking. Have the RTA checked at the next opportunity.
SPOKING LIKELY	A problem has been detected that can result in spoking to occur. Have the system checked at the next opportunity.
STAB UNCAL	An error in the antenna positioning system has been detected. Groundspoking or excessive ground returns during roll maneuvers can occur. This can be due either to the RTA or the source of pitch and roll information to the RTA.
SCAN SWITCH	The **SCAN** switch located on the RTA is OFF disabling the antenna scan. Check at the next opportunity.
XMIT SWITCH	The XMIT switch located on the RTA is OFF disabling the transmitter. Check at the next opportunity.

MAXIMUM PERMISSIBLE EXPOSURE LEVEL (MPEL)

Heating and radiation effects of weather radar can be hazardous to life. Personnel must remain at a distance greater than **R**, (shown in Figure 16-25), from the radiating antenna in order to be outside the envelope where radiation exposure levels equal or exceed 10 mW/cm^2. This is the limit recommended in FAA Advisory Circular AC No. 20-68B, August 8, 1980, Subject: Recommended Radiation Safety Precautions for Ground Operation of Airborne Weather Radar. The radius **R**, distance to the MPEL boundary, is calculated for the radar system on the basis of radiator diameter, rated peak-power output, and duty cycle. The greater the distances calculated for either the far-field or near-field is based on the recommendations outlined in AC No. 20-68B.

The American National Standards Institute (ANSI), in document ANSI C95.1-1982, recommends an exposure level of no more than 5 mW/cm^2.

Honeywell recommends that operators follow the 5 mW/cm^2 standard. Figure 16-25 shows the MPEL for the 12-inch antenna and PRIMUS 660 Weather Radar power.



DIAMETER OF FLAT-PLATE RADIATOR	5 mW/CM^2 RADIUS R OF MPEL BOUNDARY
12 IN. / 30.5 CM.	9 FT. / 275 CM.

ID-138801

Figure 16-25
MPEL Boundary

Until a beacon code is decoded, AUTO gain sets beacon receiver sensitivity to maximum to give the best chance for detecting a beacon with a matching code. When a matching beacon has been detected, the gain is automatically adjusted to keep the displayed beacon arc width correct which helps reduce sidelobe and ring-around effects.

Variable gain permits manual adjustment of beacon receiver gain. This can be useful when an uncoded beacon is being used. Preset gain is calibrated specifically for 50W beacons.

Beacon Controller 701 - Option

The PRIMUS 701 has the ability to interrogate and receive beacon codes that enable the aircraft to conduct instrument approaches into oil rigs, conduct search and rescue operations, etc. The operation of the beacon controller, shown in Figure 16-26, is described in the following paragraphs.

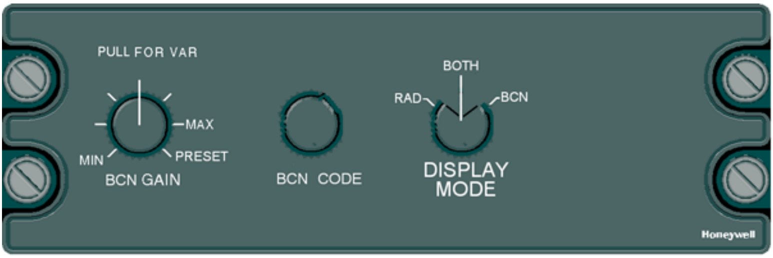


Figure 16-26
Beacon Controller

Beacon Controller Operation

- **BCN GAIN** – The **BCN GAIN** control knob controls the three possible beacon gain modes (preset, variable, and auto) as shown in Table 16-17.

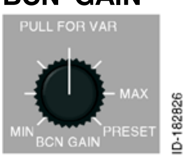
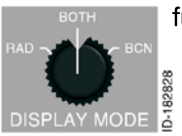


Table 16-17
Beacon Gain Modes

Control Position	Beacon Gain Mode	Annunciator
In	Auto	B AUTO
Out, Not in Detent	Variable	B VAR
Out, Not in Detent	Preset	BCN

- **BCN CODE** – The **BCN CODE** knob selects the desired beacon code. Turning the knob clockwise (cw) increases the code and counterclockwise (ccw), decreases the code. The beacon code is displayed on the MFD in the beacon box.

- **DISPLAY MODE** – The **DISPLAY MODE** knob selects one of three functions.



— **RAD** – The system shows radar data only. The beacon function is disabled.

— **BOTH** – This selection simultaneously shows both primary radar and beacons.

— **BCN** – The system shows beacons only. The radar function is disabled.

Beacon Display

When the beacon mode has been selected, a beacon window is displayed in the lower portion of the MFD with the BEACON label depicted in gray as shown in Figure 16-27. The beacon window can display the beacon type, beacon code, beacon gain bearing, and range.

Figure 16-27
Beacon Display on the MFD

The beacon type is displayed as 1P, 2P, or 6P for monopulse, two-pulse or six-pulse respectively.

The beacon code is displayed to the right of the beacon type when the beacon type is two-pulse or six-pulse. It is represented with two characters by using a leading zero when appropriate.

When variable mode is selected for a beacon mode, an amber V is displayed to the right of the beacon code. When autogain is selected for a beacon mode, a green A is displayed to the right of the beacon code. The selection of autogain or variable gain is mutually exclusive.

The magnetic beacon bearing digital readout is displayed in green. It uses three digits rounded to the nearest degree and is labeled with a degrees symbol. The readout has leading edge zeros when the bearing is less than 100 degrees.

The beacon range **readout** is displayed in green. It is rounded to a resolution of 0.1 NM when range is less than 100 NM and to 1.0 NM when range is greater than or equal to 100 NM. The beacon range readout is labeled with a white **NM** abbreviation for nautical miles.

When the beacon position is invalid, the range is removed from the display and the magnetic bearing readout is replaced by amber dashes (**- - -**).

A beacon symbol is represented by a solid white triangle that is displayed on the map using the beacon range, magnetic bearing, and map range when beacon mode is active, beacon position is valid, and weather radar is selected for display. The beacon symbol ( ) is rotated by magnetic bearing so that its base is perpendicular to the magnetic bearing.

Should there be a loss of valid heading information or valid beacon position, the beacon symbol is removed from the display.

Beacon Operation

The PRIMUS 701 always looks out 100 miles for a beacon target regardless of the selected range. It is possible to track a distant beacon and still observe close-in radar activity. Likewise, it is possible to track a close-in beacon while observing other radar targets at greater ranges.

During beacon operation, the radar sends a signal (9375 MHz) to interrogate the beacon. When the beacon receiver detects this signal, it transmits a reply on a different frequency (9310 MHz). The P-701 receives the reply and if selected by the operator, it decodes the reply. The replies are displayed on the MFD as a slightly curved arc at the proper range and bearing to accurately represent the beacons location with respect to the radar as shown in Figure 16-28.

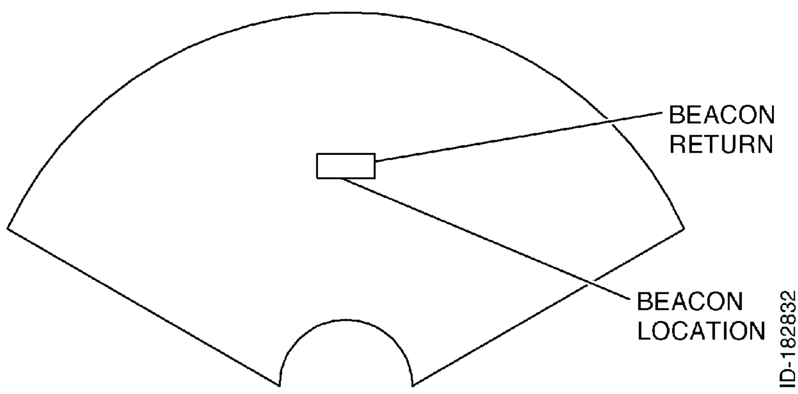


Figure 16-28
Beacon Return Display

Normally, the beacon arc is about the same width as the antenna beam width. However, when operating close to powerful beacons, it is not uncommon to interrogate and receive the beacon not only on the main lobe of the antenna but on the antenna sidelobes as well. When this happens, the beacon arc can grow in width or can break up into several arcs that smear across the screen. The worst case is a solid arc across the entire screen. This widening of the beacon is called a ring-around.

The PRIMUS 701 has a new feature called auto beacon gain. In auto beacon gain, the beacon receiver sensitivity is automatically adjusted to keep the decoded beacon return width correct and therefore reducing ring-around.

For autobeacon gain to function, there must be a beacon that has been decoded. The decoded beacon becomes the reference and the gain is adjusted based on the decoded beacons strength.

NOTE: There can be uncoded beacons that split and ring-around. Only the decoded beacon does not spilt and ring-around.

If a beacons reply matches the selected code, the radar decodes the beacons reply and a triangular decode symbol is added to the beacons display, as shown in Figure 16-29. In order to give contrasting color, the beacon reply is cyan in the WX mode and green in the MAP modes.

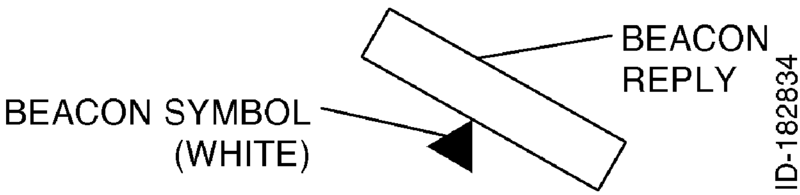


Figure 16-29
Decode Symbol

As mentioned previously, one of the uses of this radar is for overwater search and rescue operations. One question often asked is how far can a radar pick up a small boat? Unfortunately, there are several factors that affect range performance when looking for a ship at sea. The following factors are discussed in relative terms.

- **Size of the Target** - The larger the target, the greater the distance it can be detected. The larger target has more surface area to reflect radar energy.
- **Size of the Radar Antenna** - The larger the antenna, the greater the distance the radar can detect a given target. The larger antenna gives a better focus (smaller beam width) to concentrate more energy on the target and less energy on the surrounding sea.
- **Sea State** - The lower the sea, the greater the detection range. Not only does the target reflect radar energy but the surrounding waves reflect radar energy as well. The larger the waves, the more energy reflects and the more difficult it is to pick out a real target from the surrounding sea clutter.

- **Aircraft Altitude** – The lower the altitude, the greater the detection range for a given target. At low altitudes, the angle of incidence between the wave and the radar beam are such that only a small portion of the energy is reflected back to the radar. A surface target reflects more energy back to the radar, as shown in Figure 16–30, because of the incidence angle between it and the radar beam. As the altitude increases, more energy is reflected back from the waves making it more difficult to locate the real target, as shown in Figure 16–31.

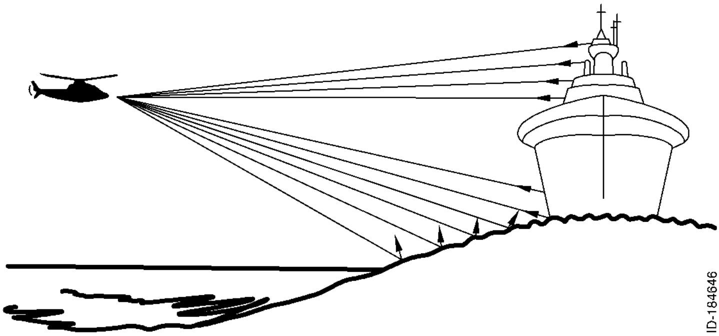


Figure 16–30
Low Altitude
Reflections From a Real Target
Versus Reflections From a Wave

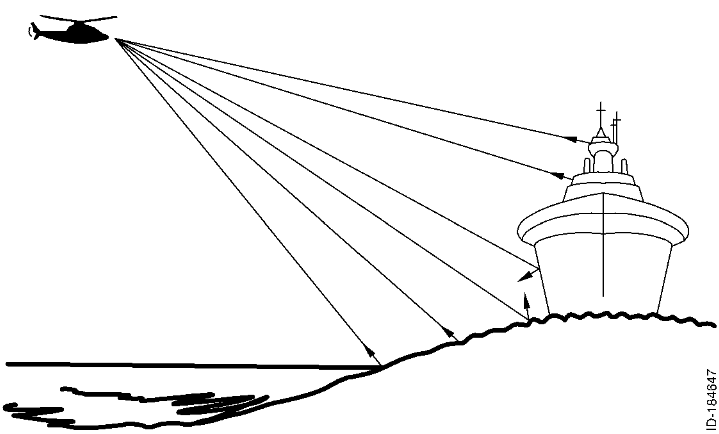


Figure 16–31
High Altitude
Reflections From a Real Target Versus
Reflections From a Wave

There are a few exceptions to the previously stated condition:

— First, if the waves are higher than the target, they mask the real target from the view of the radar. In this case, an increase in altitude improves the detection range.

— Second, the lower the altitude, the closer the horizon. This radar is a line-of-sight system and cannot see over the horizon. In this case too, an increase in altitude increases the distance to the horizon and the detection range increases.

- **Radar Pulse Length** - The shorter the pulse width, the greater the amount of energy that can be concentrated on the target and the less spills over to the surrounding sea. With this radar, the shorter the range selected, the shorter the pulse length. Therefore, the shortest possible range must be selected.

- **Radar Pulse Repetition Frequency (PRF)** - With this radar, the higher the PRF, the greater the integration. Integration helps to reduce the returns from the sea making it easier to detect the real target. With this system, the shorter ranges use the higher PRFs.

Again, the shortest range must be used.

- **Operation with Search and Rescue Radar Transponder (SART)** - A new type of compact battery powered transponder that is advertised to display on a nonbeacon radar is entering service. It is called the search and rescue radar transponder (SART) and is intended to be used on lifeboats. These beacons have been evaluated for compatability with the PRIMUS 700/701 and found that they display when the radar is in the GMAP 1 mode and in ranges of 10 NM or less. The display is a dotted line starting at the transponder location. In other modes and ranges, the SART beacon is not detected.

17. Lightning Sensor System (LSS)

INTRODUCTION

The LSS, shown in Figure 17-1, detects high-energy invisible electric and electromagnetic fields that are associated with lightning activity. Research has shown a correlation between increased lightning and turbulence that affects the proper operation of aircraft. After evaluating the LSS display, and its relation to precipitation, as indicated by the weather radar display, the flight crew can plan the proper course to avoid hazardous weather.

The LSS is an optional system on the Agusta aircraft. The LSS is used to detect and locate areas of lightning activity in a 200 NM radius around the aircraft and to give the crew a visual display of the lightning rate of occurrence and position relative to the aircraft. LSS is an enhancement to the WX system to aid the crew in finding areas of storm activity and operates in conjunction with the WX. In addition, the LSS information can display when the WX is off or failed. The LSS consists of the following LRUs:

- Lightning sensor processor
- Lightning sensor antenna
- Lightning sensor controller.

Blank Page

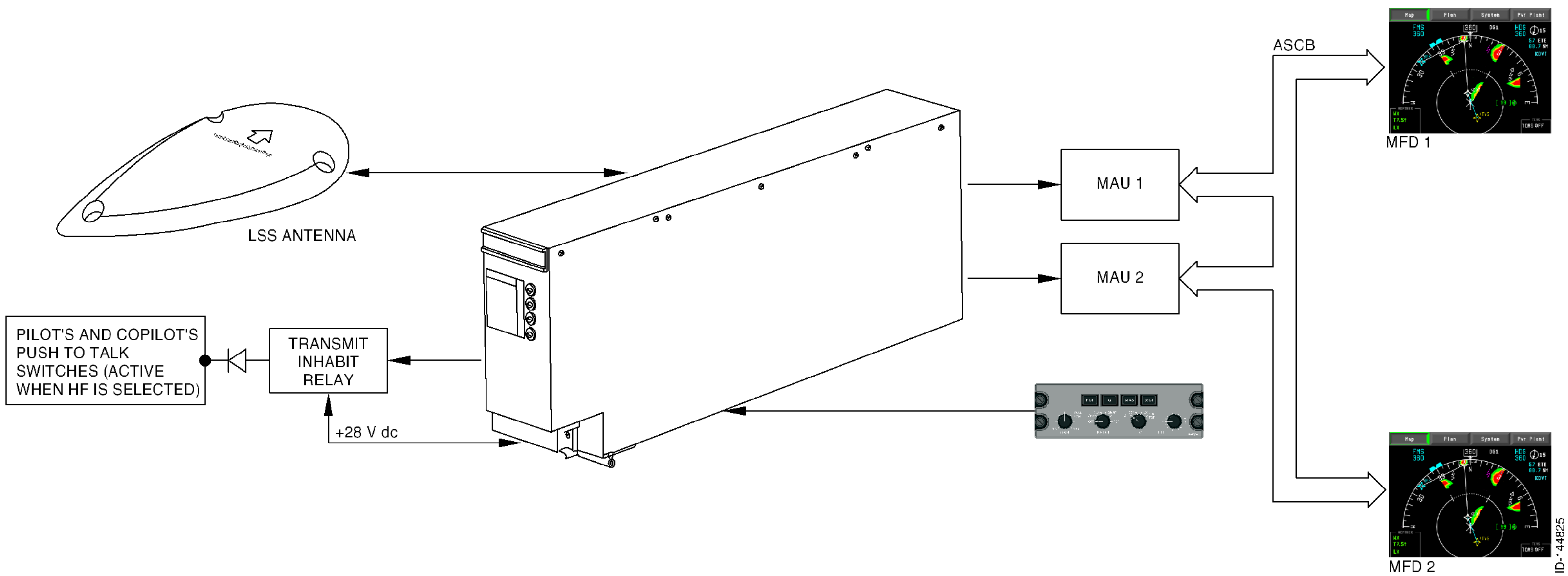


Figure 17-1
LSS System Block Diagram

Lightning Sensor System Controls

- **Weather/LSS** - When weather radar (WX) is installed on the aircraft, the LSS is controlled through the MFD MAP pull-down menu. By selecting weather and moving the display cursor to the white pointer ▶, shown in Figure 17-2, the LSS virtual controller is displayed. A selection is made by placing the cursor over the box next to the desired selection and pushing the **ENTER** button on the CCD. A green √ appears in the box turning on the selection. Pushing **ENTER** button again removes the green √ and turns OFF the selection.

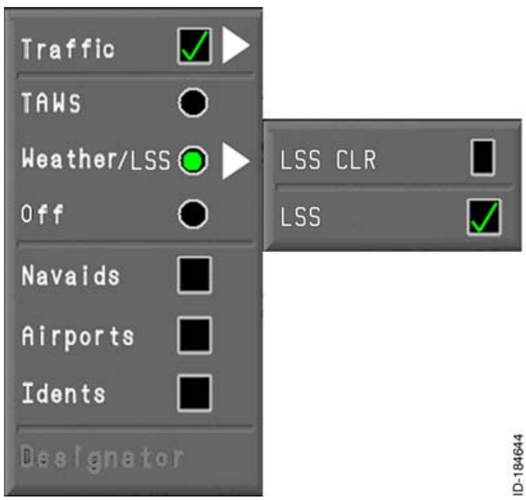


Figure 17-2
Weather/LSS

- **LSS CLR** - In the clear mode, all memory of past strikes and symbols are cleared.

- **LSS** - When the LSS box is checked, lightning strikes are being collected, processed, and displayed. When the LSS mode is ON, the lightning strikes are displayed on either MFD. Deselecting the LSS mode removes the lightning information from the screen. The displays work independently so either the pilot or copilot or both can select the LSS display and can have the displays set at different ranges.

In the test mode, which is activated by selecting **LSS** on the MCDU TEST page, simulated lightning signals are fed to the antenna and a lightning strike is simulated at a bearing to the aircraft symbol of 45° at 25 NM. This simulated strike progresses in severity up to a lightning rate three within 15 seconds after the test mode has been initiated. In addition, a lightning alert is generated along the outermost range ring at a bearing of 45°. The lightning rate symbol is removed after two minutes.

NOTES:
1. When the LSS is in the test mode, the antenna is used, and as a result, any real activity that occurs while the test is in operation is displayed.
2. Some installations can see slight symbol motion due to analog true-airspeed input.

TEST MODES

The LSS performs an automatic self-test when power is turned ON and during the normal LSS operation. In addition, the crew can initiate a self-test. The three self-test functions are as follows:

- **Power-On Self-Test (POST)** - When power is applied to the LSS, the processor automatically checks electrically programmable read only memories (EPROM), random access memory (RAM), configuration straps, and power supply voltage.
- **Online Built-In Test Equipment (BITE)** - This is a monitoring function that continuously monitors the operation of various circuits in the system during operation.
- **PAST** - The crew can verify the operation of the LSS by selecting the LX clear mode on the LSS menu. The test sends simulated lightning activity to the antenna for a complete end-to-end test of the system. This results in a lightning symbol display at a bearing of 45° right at 25 NM. The simulation advances the severity to a lightning rate three within 15 seconds after entry into the test mode. A lightning alert is generated along the outermost range at a bearing of 45° right and remains for three to seven seconds. The rate three symbol degrades and fades out within two minutes.

Lightning Sensor System Mode Annunciators

The LSS annunciators are displayed in the last line of the weather window. Table 17-1 lists all LSS modes, annunciator text, and annunciator color.

Table 17-1
Lightning Sensor System Mode Annunciators

Annunciator	Mode	Condition
LX	LSS	The system is in the normal operating mode.
LX	LSS interface failure	LSS power is ON and a fault condition exists.
LX/FAIL	LSS fault detected	LSS failed.
LX_{MN}	LSS fault code displayed	LSS clear mode selected and PAST activated displaying fault codes (Notes 3, 4)
LX/INHIB	LSS input inhibited	The receiver is inhibited by the XMIT INH input during transmission by communications transmitters. No lightning is received in this condition.
LX/STBY	LSS Standby	LSS set to standby.
LX/CLEAR	LSS clear	The system is in the clear (CLR) mode. This occurs for approximately three seconds after the CLR/TST mode has been selected. After three seconds, the mode annunciator switches to LX/T.
LX/TEST	LSS test	The system is in the TST mode. This annunciator can be replaced with a display in the form LX_{MN}, where MN is a hexadecimal fault code.

Table 17-1 (cont)
Lightning Sensor System Mode Annunciators

Annunciator	Mode	Condition
LX/HDG	LSS heading input deselected/ unavailable	The heading input has been deselected, either by the pilot (if a HDG select switch is fitted) or by the HDG VALID input.
LX/CAL	LSS calibration	This annunciator indicates that the system is in the self-calibration mode. This reverts to the selected mode approximately 10 seconds after power is applied (Note 2).

NOTES:

1. It is possible that two or more of the above situations can be true at the same time. In that case, the annunciator that is highest on the above list is displayed.
2. The LX/C annunciator is unique. During the first 8 seconds after power is applied, the LSS performs a self-calibration process to cancel out variations in antenna gain and cable loss. As soon as the test is complete, the letter **C** is removed from the display. If strong interfering signals outside the aircraft or equipment malfunction prevent the calibration of the system, it reverts to preset calibration factors, in which case, the **C** is not removed from the display. In this case, the pilot must select the TST mode and evaluate the test display. The displayed target at 45° right, 25 NM range must be within 5 NM of that position. If this is the case, the system is usable, and the LX/C annunciator does not indicate a failure of the system. Interference signals can be a result by other systems on the aircraft, by adjacent ground installations such as power transformers, or by nearby aircraft. If sources outside the aircraft are the reason the **C** remains displayed, they are not displayed after takeoff. The LSS must be switched off and set back to the LX mode to force recalibration for greater accuracy. If the **C** display persists after takeoff, the test display must be reevaluated.
3. **M** represents the four most significant bits of the fault code and **N** represents the four least significant bits of the fault code. The display gives fault codes ranging from 00 through FF
4. For multiple failures, the LX processor updates the LX fault code once every three seconds. The display updates to the current LX fault code.

When the POST or the BITE detects a fault, either before or during operation of the pilot-activated self-test, the system switches the displayed mode symbol to a LX/F. The pilot can display a fault message by selecting LX clear mode. In the LX clear mode, an LX_{MN} is displayed, where MN is a failure code that is described in the following list.

LX FAIL CODE (MN)	HARDWARE/FIRMWARE FAILURE
00	No LX system failure (not displayed)
01	Power supply out-of-tolerance
02	Invalid configuration
03	Reserved
04	Data Processor RAM failure
05	Data Processor Checksum failure
06	Data Processor Shared RAM failure
07	Reserved
08	Reserved
09	I/O Processor RAM failure
0A	I/O Processor Checksum failure
0B	I/O Processor Shared RAM failure
0C	H_N out-of-range
0D	H_W out-of-range
0E	Reserved
0F	Reserved
10	Reserved
11	Reserved
12	No data from antenna

Lightning Sensor Symbols

The LSS indicates cells of lightning activity using white **rate-of-occurance** symbols that show three levels of lightning activity in a circular cell around the symbol. The white **rate** symbol upgrades in level as more lightning strokes are detected in the cell. It downgrades in level as two minutes pass with no new lightning strokes being detected.

The three white lightning **rate-of-occurance** symbols and the magenta **alert** symbol are shown in Figure 17-3.

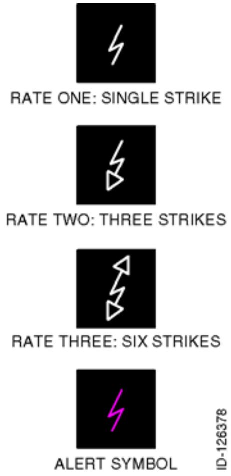


Figure 17-3
Rate-of-Occurrence Symbols

The white **rate** symbols location represents the average position of lightning strokes that have occurred within a circular cell around the symbol, as shown in Figure 17-4.

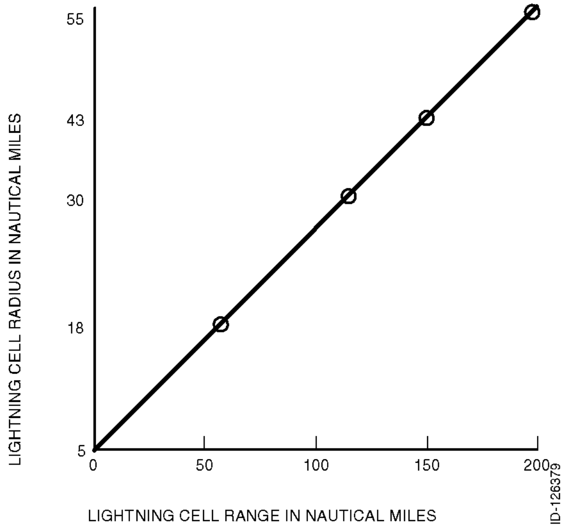


Figure 17-4
Lightning Cell Size vs Range

The rate symbol location is updated with every new lightning stroke in the cell. The LSS uses the strongest part of the strike to place the rate symbol or to update its location, however, a lightning stroke can cover several miles. Therefore, because of the rate and position averaging, lightning cannot be occurring at the exact location of the white **rate** symbol.

When cells overlap, a new lightning stroke in the overlapping area is averaged into the first cell formed that covers the stroke location. When the updated locations of two overlapping cells come within the cell radius of each other, the cells are replaced with one cell at the averaged location.

The lightning **alert** symbol is magenta and the same shape as the rate one symbol. The alert symbol is only displayed at the outermost range arc of the display and is shown for five seconds to indicate a lightning stroke on that bearing, either within or beyond the selected weather radar display range.

Cloud-to-cloud lightning strokes are difficult to range accurately and normally are displayed as the alert symbol at the proper bearing.

THE RATE AND POSITION AVERAGING

When the first lightning stroke occurs, the magenta alert symbol is displayed for five seconds on the bearing of the stroke, and a white rate one symbol is displayed at the strongest part of the stroke. If 30 seconds later, another stroke is detected in the cell, an alert symbol is displayed for five seconds. The rate shape is not changed, but its location is moved to the average position of the two strokes. If another stroke is detected within 30 seconds, an alert symbol is displayed for five seconds, the rate symbol is upgraded to a rate two symbol and the location is changed to the average of the three strokes. After one more minute and no lightning stroke is detected (two minutes after the first stroke), the rate symbol is downgraded to rate one but the position is not moved. If no more strokes are detected in the cell within one more minute (two minutes after the last stroke), the rate symbol is removed from the display. If additional strokes are detected, the rate symbol is upgraded to rate three and its position is updated. Any strokes detected outside existing cells results in other cells forming and a rate symbol is displayed at the new locations.

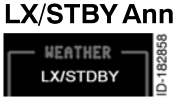
Weather and Lightning Displays

The WX image with lightning layered on top of it, is shown in Figure 17-5.

The white **rate** and magenta **alert** lightning-rate symbols, which represents both position and rate-of-occurrence of lightning strokes, make up a display that is uncluttered and easy to read.

Figure 17-5
MFD With Lightning Displayed

- **LX/STBY Annunciation** – In order for lightning to be displayed, WX must be ON. When the WX is OFF, the weather window diminishes in size and **LX/STBY** is annunciated. This is due to the fact that once power is ON, there is no way of shutting OFF the LSS. The pilots are therefore kept informed about the status of the LSS. It is either ON, in standby, or in a failed condition.



The LSS receives inputs from one or combinations of several other systems that are typically found on the aircraft. The pilot must be familiar with the aircraft installation to know what features are active. These inputs are latitude/longitude from the flight management system (FMS), heading from the micro attitude and heading reference system, and airspeed from any one of several sources.

Generally, these inputs position the lightning-rate symbol accurately on the display. The displays are updated with both heading and velocity information to keep the rate symbol over the same geographic location regardless of how the aircraft is maneuvered. This feature is called **Geographic Stabilization**. The LSS computer can track up to fifty (50) individual lightning-rate symbols.

18. Traffic Alert and Collision Avoidance System (TCAS)

INTRODUCTION

The TCAS is an independent airborne system that does not rely on air traffic control (ATC) for control or coordination for traffic separation. It is designed to act as a backup to the ATC system and the see and avoid principle. It detects unsafe traffic conflicts with other transponder-equipped aircraft and assists the flight crew in avoiding intruders inside a protected airspace. This is done by interrogating surrounding aircraft with Mode A, Mode C, and Mode S transponders, tracking the responses, and issuing advisories to the flight crew of the vertical separation from intruders, as shown in Figure 18-1.

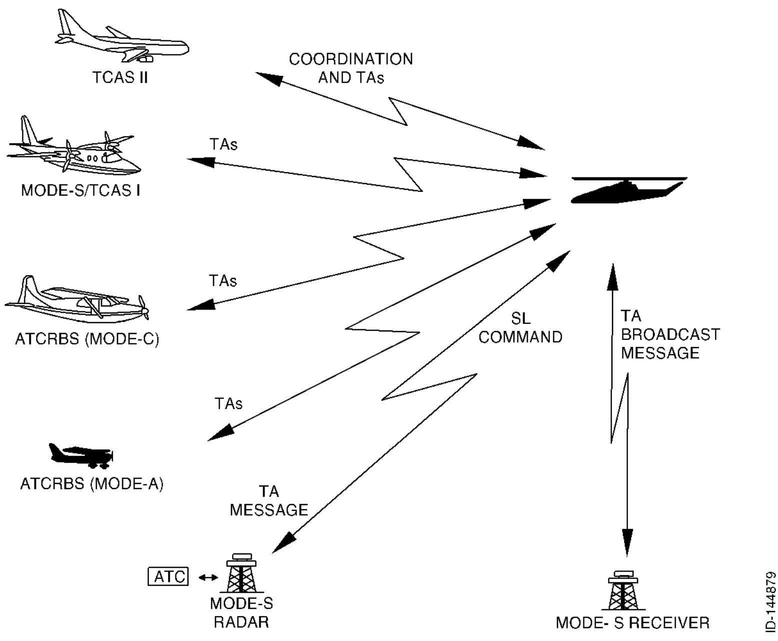


Figure 18-1
Transponder Interrogation Capabilities

The TCAS tracks all transponder equipped aircraft. TCAS works like a secondary surveillance radar, scanning 360 degrees in one second. To establish a track on a target, the TCAS must sense four good replies from a transponder. On the fifth valid reply, the TCAS begins to display the target on the screen. When the target meets the advisory criteria, TCAS issues the advisory.

The interrogation reply enables TCAS to compute the following information about the intruder:

- Range between aircraft and intruder
- Relative bearing to the intruder
- Altitude and vertical speed of the intruder
- Closing rate between intruder and aircraft.

TCAS separates the surrounding airspace into two altitude layers. A different sensitivity threshold level for insuring TAs (traffic advisories) is applied to each altitude layer. Lower altitudes have less sensitive TA threshold levels to prevent unnecessary advisories in the higher traffic densities anticipated at lower flight levels, such as terminal areas.

TCAS Operation

MFD MAP MENU

The Traffic button, shown in Figure 18-2, is selected by using the **ENTER** button on the CCD when the Traffic button is highlighted. It toggles the display of TCAS traffic information on the MFD ON and OFF. Selecting the right arrow button on the CCD joystick, when the Traffic item is highlighted, shows the TCAS display configuration menu. The TCAS display configuration menu is used to control the display of TCAS traffic information using either RELATIVE or FLT LEVEL (absolute) altitudes.

Figure 18-2
MAP Menu Showing TCAS Configuration Submenu

Selecting **FLT LEVEL** shows absolute altitudes for display. The power-up default for the TCAS target is the **RELATIVE** altitude menu item. When **FLT LEVEL** is selected for display, the setting automatically reverts to the relative state after 15 seconds.

The TCAS display configuration menu selects the altitude range for which traffic is displayed using one of the following four ranges:

- NORMAL = ±2700 ft
- ABOVE = –2700 to +9000 ft
- BELOW = –9000 to +2700 ft
- EXPANDED = –9000 to +9000 ft.

The power default TCAS altitude display range is in the NORMAL range.

Vertical guidance to avoid midair collisions is used to compute advisories. TAs indicate the range, bearing, and relative altitude of the intruder to aid in visual acquisition of the intruder, and assist in two pilot decision making actions:

- **Corrective** - Pilot-action is required
- **Preventive** - Current path and speed must be maintained.

In either case, the crew response must be to visually acquire the intruder, and maintain visual acquisition of the intruder to ensure safe operation.

NOTE: Mode A equipped intruders can be detected and displayed only as TAs. Intruders not equipped or not using their transponder are invisible to TCAS.

TCAS generates TAs when the TA mode is selected on the MCDU RADIO 1/2 page, as shown in Figure 18-4. The two types of advisories correspond to time-based protection zones around the aircraft.

Only one Mode S transponder in the protected aircraft is required for TCAS operation. When two Mode S transponders are installed, the selected transponder is used by TCAS, the other operates as a backup. The TCAS receiver/computer uses its directional antenna to display intruder bearing.

A TCAS map overlay format can be displayed on the MFD. At a maximum range of 18 NM, TCAS tracks up to 45 targets. The traffic symbols displayed are limited to the 30 highest priority intruders in order to avoid clogged displays with low priority intruders.

TCAS tracks other transponder equipped aircraft that are within a relative altitude of $\pm$10,000 ft.

Each pilot can control the on-side TCAS display independent of the selected controls on the other side.

MCDU Transponder (XPDR)/TCAS Radio Control

The transponder and TCAS radios are controlled using the two MCDUs mounted in the center console. In addition, some TCAS displays are available on the MFD MAP menu and are described in detail later in this section. The XPDR/TCAS system supports one or two transponders.

In each MCDU, there are three types of display pages used to control the transponders. The main transponder page is RADIO 1/2, the detail transponder page is XPDR/TCAS 1/2, and the detailed TCAS page is XPDR/TCAS 2/2.

Figure 18-3 shows routing between RADIO page 1/2 and TCAS/XPDR pages 1/2 and 2/2. By selecting LSK 5L, the TCAS/XPDR 2/2 page is displayed and selecting LSK 5R shows the XPDR 1/2 page.

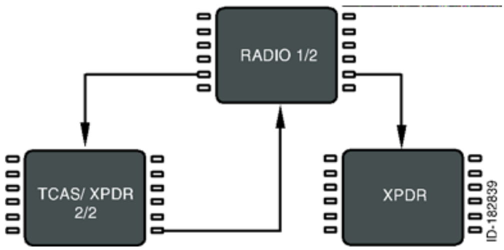


Figure 18-3
RADIO 1/2 and TCAS Logic Diagram

RADIO 1/2 PAGE

The RADIO 1/2 page shows four lines for transponder radio control, as shown in the bottom area of Figure 18-4. The TCAS/Transponder display controls are listed below:

Figure 18-4
RADIO 1/2 Page, COM Tuning

- **5L TCAS/XPDR** – Pushing this key takes the system to the TCAS/XPDR 2/2 page.
- **6L STBY TA** – Push this key to alternately select STBY or the selected active mode. The **ACTIVE** condition is green, the inactive annunciator is **white**.

  Modes available on TCAS/XPDR 2/2 are:

  — TA

  — ALT-ON

  — ALT - OFF.

- **5R Active Transponder Code and Reply Indicator** – This section shows the active transponder code and reply indicator. The header for field 5R shows the flight ID, if it is available or was entered by the crew. The reply indicator ( ) lights when the transponder is replying to a RADAR or TCAS interrogation. Pushing LSK 5R moves the format cursor to the field or shows TCAS 1/2 if the cursor is already in the field.

  Transponder codes can be inserted directly from the MCDU scratchpad by typing the new code into the scratchpad and selecting 5R. If the code is valid, the MCDU transfers the scratchpad code to the active transponder code field and clears the scratchpad. The original active transponder code is moved to the PRESET code field at 5R.

  If the code is invalid, an error message is displayed in the scratchpad and no transfer takes place.

- **6R IDENT** – To transmit an IDENT reply when requested by ATC, push the line select button at 6R next to the IDENT label. This function is only available if the white box ( ) is displayed next to the IDENT label, as shown in Figure 18–4.

TCAS/TRANSPONDER 1/2 DETAIL PAGE

The TCAS/XPDR pages control the active transponder. The reply code and identifiers are on the left side of the display with mode controls on the right and page transfers at the bottom. Figure 18-5 shows the TCAS/XPDR 1/2 detail page.

Figure 18-5
TCAS/XPDR 1/2 Page, Transponder Tuning

- **1L ACTIVE** – The adjustable transponder reply code is displayed in green. The tune key indicates the code is adjustable using the tuning knob on the MCDU. Refer to the procedures below for operating instructions for the **ACTIVE** and **PRESET** fields.

- **2L PRESET** – The preset transponder code is displayed here. When the cursor box surrounds the display, the tune icon is displayed to indicate that the code is adjustable using the tuning knob on the MCDU.

- **5L** XPDR SEL – This key toggles between XPDR1 and XPDR2 as the active transponder. The selected transponder turns green and the font is larger. The unselected sources are white in a smaller font.

NOTE: Unless an additional transponder is incorporated into the aircraft, only one XPDR is annunciated.

- **1R** PRESSURE ALT – The pressure altitude digital value is displayed in white. This is the altitude that the transponder is sending to ground stations and other transponder equipped aircraft.

- **2R** FLT ID – This location shows the loadable flight ID.

- **5R** IDENT – To transmit an IDENT reply when requested by ATC, push the line select button at 5R next to the IDENT label.

- **6R** RADIO 1/2 – Pushing this key returns the display to the RADIO 1/2 menu.

ENTERING A NEW REPLY CODE

To enter a new reply code directly using the scratchpad, follow the procedure below.

1. Type the 4-digit code into the scratchpad using the numeric keypad.

2. Push 1L at the ACTIVE transponder code. The cursor box does not have to be on the intended destination field.

The MCDU checks the scratchpad for a valid transponder code. If it is valid, the MCDU transfers the scratchpad code to the active transponder code field and clears the scratchpad. The original active transponder code is moved to the PRESET code field at 2L. If the code is invalid, an error message is displayed in the scratchpad and no transfer takes place.

Direct tuning of the transponder code using the knobs is not permitted. The standby tuning procedure must be used as described in the following paragraphs.

SWAPPING PRESET AND ACTIVE CODES

The PRESET transponder code is located adjacent to 2L. The PRESET code can be changed using the tuning knobs when the cursor box has it selected and the curl prompt is displayed.

To change the **PRESET** code and load it into the **ACTIVE** code, follow the procedures listed in the following paragraphs:

1. Push the line select button at 2L next to the **PRESET** code to move the cursor box over it, if it is not already there. The default position for the cursor on this page is 2L.
2. Change the **PRESET** code using the larger knob to change the high order portion of the code and the upper smaller knob to change the lower portion. The default reply code is 1200 (VFR).
3. Push the line select button when the swap icon is displayed for the **ACTIVE** button at 1L. The **ACTIVE** code and the **PRESET** code are exchanged.

TRANSPONDER 2/2 DETAIL PAGE

The TCAS/XPDR 2/2 detail page, shown in Figure 18-6, is used to control the rest of the transponder/TCAS functions.

Figure 18-6
TCAS/XPDR 2/2 Page, Transponder Tuning

- **1L TCAS/XPDR MODE** – Pushing this key toggles from TA, ALT-ON, and ALT-OFF. The selected mode is shown in a larger font green, the others are smaller font white.

- **6R** **RADIO 1/2** – Pushing this key returns the display to the RADIO 1/2 menu.

TCAS DISPLAY

The TCAS display on the MFD is shown in Figure 18-7. It includes the helicopter symbol, targets, and a range ring.

Figure 18-7
MFD TCAS Display

NOTE: TCAS traffic is not displayed on the PFD. Once a TA is announced, an annunciator of TRAFFIC is displayed on the PFD in the upper left corner of the attitude sphere.

TCAS Status Window

A TCAS status window is displayed in the lower right corner of the MFD MAP Menu (when TCAS is installed). The window is displayed using the TCAS installed APM parameter. The TCAS status window gives the following indications.

- The TCAS target filtering status is indicated by the annunciators NORMAL, ABOVE, BELOW or EXPANDED.
- When absolute altitude display mode is selected for TCAS targets, the annunciator is FLT LEVEL.

- When the TCAS indicates a functional test, the **TCAS TEST** annunciator is displayed.

- When the TCAS is valid or indicates a functional test and TCAS is in standby, the **TCAS OFF** annunciator is shown.

- When the following conditions are present, a **TCAS FAIL** annunciator is shown.

  — TCAS bus fails

  — TCAS indicates a TCAS system failure

  — TCAS control word indicates failure or no computed data

  — TCAS computer fails.

The TCAS status annunciators are displayed in a single field using the following priority from highest to lowest:

- **TCAS TEST**

- **TCAS OFF**

- **TCAS FAIL**

- TCAS filtering status.

Range Ring

When traffic information is selected for display on the MFD from the Map drop-down menu bar, a ring of 12 white small **circles** and dots are displayed at a radius of two nautical miles around the helicopter symbol. The dots are arranged so that one dot is placed at each of the clock hour positions, the helicopter symbol with current heading being the 12 o'clock position. The two-mile range ring is displayed proportional to the current MFD range selection. When the MFD range is ≥25 NM, the range ring is removed. If valid TCAS information and valid heading information from AHRS is lost, the 2 NM range ring is removed from the display.

TCAS Target Types

The TCAS menu and CCD are used to select TCAS range, target filtering, and absolute or relative altitude for the on side display. The type of target is determined by its symbol and color. The following are target types:

- **Traffic Advisory (TA)** – A symbol change to a filled amber circle indicates that the intruding aircraft is considered to be potentially hazardous. TCAS shows a TA when time to CPA (closest point of approach) is 15 to 30 seconds. These are potential threats if conditions do not change.
- **Proximate Traffic (PT)** – A filled cyan diamond indicates that the intruding aircraft is within ±1200 ft and within 5 NM range, but is still not considered a threat. These could be a potential threat if direction or altitude is changed.
- **Other Traffic (OT)** – An open cyan diamond indicates that an intruder relative altitude is greater than ±1200 ft, or distance is beyond 5 NM range. It is not yet considered a threat.
- **No Bearing Target** – These are targets whose transponder is being received (code and altitude) but the TCAS system is unable to determine the bearing to them.

NOTE: For TAs, if the target is outside the currently selected display range, only the right half of the target symbol is displayed along the outside arc at the appropriate bearing.

- **Vertical Speed Symbol** – When the intruder vertical speed is 500 fpm or greater, a vertical arrow (↑) is placed to the right of the intruder symbol, and it points in the direction of the intruder vertical speed. The arrow is the same color as the intruder symbol.

ID-148843

- **Relative Altitude Display** – Relative altitude is the altitude difference between the intruder aircraft and the present aircraft altitude. The relative altitude values are rounded off to the nearest 100 feet. A **+** or **–** is used to indicate whether the intruder is above or below the present aircraft altitude. The remaining two characters are the relative altitude in hundreds of feet (such as, for the **-04** means –400 feet).

NOTE: Absolute altitude is replaced with relative altitude when a TA condition is encountered.

When the intruder aircraft is located below the present aircraft altitude, the relative altitude is displayed below the intruder symbol. When the intruder aircraft is located above the present aircraft altitude, the relative altitude is displayed above the intruder symbol. The display color of the relative altitude is the same color as the intruder symbol.

- **Absolute Altitude** – The absolute altitude display can be selected for display using the TCAS menu on the MFD. When absolute altitude is displayed, the actual altitude is displayed in a three-digit format (such as, 060 equals 6000 feet, or 310 equals 31,000 feet). The absolute altitude display times out 10 seconds after it is selected and the display reverts to relative altitude.

ID-148843

The absolute altitude values are rounded off to the nearest 100 feet. When the intruder aircraft is located below the present aircraft altitude, the intruder absolute altitude is displayed below the intruder symbol. When the intruder aircraft is located above the present aircraft altitude, the intruder absolute altitude is displayed above the intruder symbol. The display color of the intruder absolute altitude is the same color as the intruder symbol.

- **No Bearing Target Readout** – The no bearing display is a text field

that consists of an underlined no bearing annunciator and information about the two most critical no bearing intruders. The no bearing display one and two consists of a TA annunciator, range readout, altitude readout, and climb/descend indication. The TCAS computer automatically prioritizes the most critical no bearing available intruders into the first two no bearing displayed intruders. The **display** is amber. However, the display flashes when the condition is extremely urgent.

  For example, a target creating a TA at 1.2 NM, 600 feet below the helicopter and climbing ≥500 FPM, is displayed as **TA 1.2 -600 ↑**.

INVALID TCAS

The following TCAS failures and their results occur when valid TCAS information is lost:

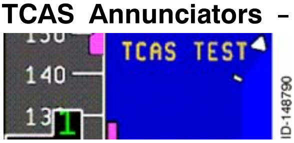
- If valid TCAS information is lost, PT, TA, and OT symbols are removed from the display.
- If valid vertical speed indications from TCAS are lost, the vertical speed arrows are removed.
- If valid relative altitude information from TCAS is lost, the relative altitude data tags are removed from the display.
- If valid barometric altitude information from the ADS is lost, the relative altitude information is removed.

PFD TCAS Displays

ATTITUDE DIRECTOR INDICATOR (ADI)

A resolution advisory (RA) is an automatic display indication given to the pilot that recommends a maneuver to increase vertical separation relative to an intruding aircraft.

- **TCAS Annunciators** – All TCAS annunciators are located as



shown on the PFD. When the TCAS detects an intruding aircraft that is considered to be potentially hazardous, aural and visual TA alerts are displayed on the PFD. **TRAFFIC** is displayed in the upper left corner of the attitude sphere when a traffic advisory is indicated by the TCAS processor. In this example, **TCAS TEST** is displayed.

The following TCAS status annunciators are displayed in the upper left corner of the attitude sphere:

- TCAS TEST
- TCAS FAIL
- TCAS OFF.

TCAS AURAL ALERTS

Aural alerts are announced over the aircraft audio system. Audio levels for the aural alerts are preset and not crew-adjustable. The alerts accompany the visual TA displays and the audio are softened or strengthened based on the urgency of the situation. Table 18-1 lists the aural alerts.

Traffic Advisory Aural Alerts

Table 18-1
TA Aural Alert Messages

TA Aurals	Meaning
Traffic - Traffic	This alert occurs when TCAS predicts an intruder enters the collision area within 35 to 45 seconds. Simultaneously, the TCAS traffic display shows the location of the intruder.
Traffic	This alert occurs when a previous TA is active.
TCAS System Test OK	This aural occurs at the conclusion of a passed self-test.
TCAS System Test FAIL	This aural occurs at the conclusion of a failed self-test.

NOTE: TCAS inhibits aural annunciator when the aircraft is below 400 ft AGL.

TCAS TEST

The TCAS test is accessed by pushing the LSK 4L on the TEST 1/1 so the OFF-ON indication is **ON**, as shown in Figure 18-8. Pushing the TCAS test button starts the test cycle and shows the TCAS test pattern on the MFD. When the test is complete, the test display reverts to the original MFD screen. This test does not require crew-intervention to exit the cycle, as it turns itself OFF automatically. Figure 18-9 shows the MFD TCAS test.

Figure 18-8
MCDU With TCAS TEST Selected

Figure 18-9
MFD TCAS Test

19. Terrain Alert Warning System (TAWS)

INTRODUCTION

TAWS gives terrain display, situational awareness, terrain/obstacle warning and advisory callouts to the pilot.

NOTE: The Agusta AW139/AB139 utilizes the MK XXII enhanced ground proximity warning system (EGPWS), shown in Figure 19-1.

The TAWS system gives the pilot superior situational awareness with respect to terrain and known obstacles. In addition, the TAWS system contains an advanced alerting and warning functionality to warn the pilot of impending danger with respect to terrain, man made obstacles and other primary scenarios associated with the dangers of controlled flight into terrain (CFIT).

Figure 19-1
Mark XXII EGPWS

TAWS uses aircraft inputs including:

- Radio altitude and DH
- Roll and pitch attitude
- Baro altimeter and V/S
- Ground speed and track
- Localizer and glideslope
- Engine torque
- Airspeed
- OAT
- GPS signal quality

- Gear position
- Weight on wheels
- Magnetic heading
- Display range
- GPS position
- GPS altitude

These inputs use internal terrain, obstacles, and airport databases to predict a potential conflict between the aircraft flight path and terrain or an obstacle. If a terrain or obstacle conflict exists, the TAWS sounds an audio caution or warning alert, and shows a display of the situation. The TAWS alerts the pilot as to excessive glideslope deviation, when the aircraft is too low or when the aircraft is not in a landing configuration. In addition, it can warn of excessive bank angles and altitude callouts, as shown in Figure 19-2.

TAWS outputs include:

- Terrain/obstacle display
- Voice alerts/warnings/callouts
- Visual cautions/warnings.

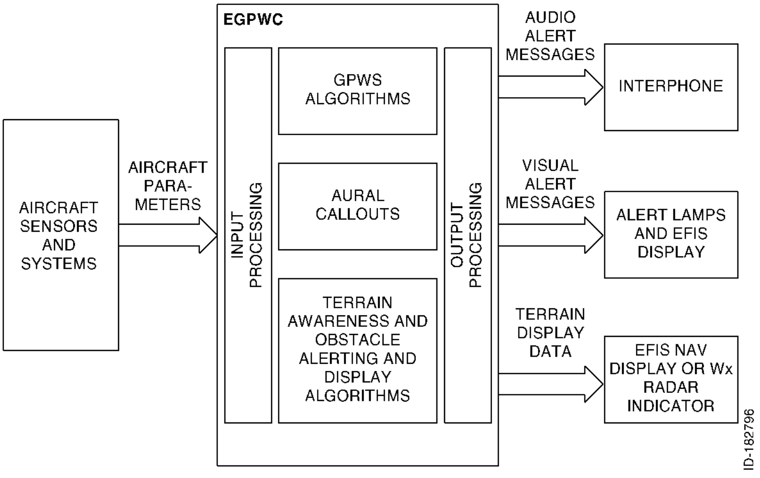


Figure 19-2
TAWS Input/Output Diagram

NOTE: TAWS inputs and outputs are discussed in further detail in Section 2, System Description in this guide.

During normal flight operations, the TAWS remains essentially silent. Using GPS, radio and barometric altitude, airspeed, altitude rate, pitch and roll attitude, magnetic heading and temperature data in combination with its various database information, the TAWS gives the pilot a display of the aircraft position relative to surrounding terrain and known obstacles, giving enhanced situational awareness for the pilot.

Should the aircraft fly into danger where a conflict with terrain or a known obstacle is imminent, the TAWS gives a combination of annunciator lights, color display, and aural alerts to the pilot. In addition, TAWS gives alerts and warning for excessive rates of decent, bank angle and inadvertent descents or altitude loss after take off. TAWS warns against descending below the glideslope on an ILS and against high pitch attitudes near the ground for tail strike.

Pilot reactions to alerts, warnings, and advisories differ according to weather conditions, visibility, and type of alert, phase of flight, and aircraft performance considerations.

Function and Features

TAWS always knows where it is relative to the ground. The system continually compares the GPS position to the terrain database.

TAWS uses the global positioning system (GPS) information from either an aircraft-installed GPS receiver, or an internal GPS receiver contained in the TAWS computer itself. It is necessary for the pilot to be aware of the actual position source being used by the EGPWS, as the internal GPS is not used for navigation of the aircraft.

GPS signals arrive at an antenna on the aircraft and are processed by the TAWS computer to give both horizontal and vertical position information. This position in space is compared to the terrain and obstacle database information contained in the TAWS computer to produce a virtual picture which can be displayed to give situational awareness to the pilot.

Information from GPS and other aircraft systems are used by TAWS to calculate track, ground speed, vertical velocity, and signal accuracy. This gives a complete picture of not only the aircraft position in three dimensions, but an excellent picture of the aircraft flight path and the health of the enhanced ground proximity warning system.

When the GPS view of the satellites is momentarily obstructed by terrain shadowing or when in a turn, the EGPWS goes into a dead reckoning mode for up to 60 seconds. If the satellite shadowing lasts longer than 60 seconds, the **TERR INOP** is annunciated on the PFD and the **Be Alert, Terrain INOP**aural message is given.

This total package of information is used to give terrain displays for the pilots, and to give alerting and warning functionality. This protects the pilot and passengers from possible conflicts with terrain, known obstacles, and other scenarios associated with the dangers of controlled flight into terrain (CFIT).

Aircraft Altitude

TAWS uses barometric pressure, radio altitude and a special GPS derived altitude developed by Honeywell called Geometric Altitude. It gives more accurate altitude information, which is using the same mean sea level (MSL) reference as the terrain, obstacle and runway/helipad databases in the system. The blending functionality of Geometric Altitude means it is much less susceptible to errors induced by the pilot, cold temperature or malfunctions in altimeter systems. Where aircraft are routinely operated in extreme temperature conditions (either hot or cold), the blending formula of Geometric Altitude gives an even more accurate vertical position to the TAWS. This prevents serious discrepancies between actual altitude and Geometric Altitude under extreme temperature conditions, especially during rapid climbing or descending flight profiles.

NOTE: The pilot is NOT required to enter an altimeter setting specifically for the TAWS system.

Signal Quality

The TAWS computer continually monitors the information it receives for reasonability and assigns these inputs a quality value. This value is used to modify the caution and warning Look-Ahead envelope.

Software and Database Loading

Software and the terrain and obstacle databases are loaded from a PCMCIA card with the Smart Cable Loader. This is a lightweight unit that does not require any external power. Separate cards are available for software and database updates. The database card contains all the terrain data and known obstacles data (where available), used by TAWS. Instructions for update procedures of the database card are discussed later in this guide.

Terrain, Obstacles and Runway Database

Terrain data is supplied from the same proprietary database used by other Honeywell EGPWS products, and is divided into nine overlapping regions that cover the world, as shown in Figure 19-3. The terrain data is divided into grid patterns of various sizes, from areas of about 600 feet square resolution to areas of about 5 NM square. This permits a large area of data to be stored in the unit and permits high-resolution for areas to be more accurate where the data is available. For a current description of the high-resolution database coverage, contact the Honeywell Database department through the Internet web site at http://www.egpws.com.

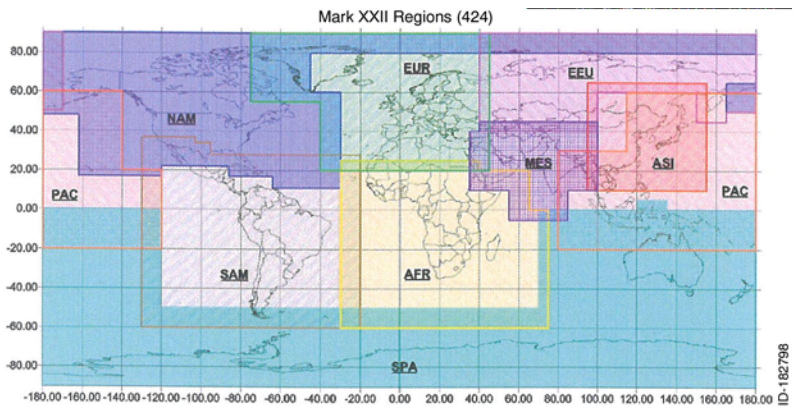


Figure 19-3
Database Regions

Data for known obstacles (such as towers, buildings, antennas, etc.), are contained on the same data card as the terrain and airport data. Presently, obstacles are included for North America (NAM), parts of Europe (EUR), portions of the South Pacific (SPA), portions of the Pacific (PAC) and portions of the Middle East (MES) regions. As more reliable information becomes available, Honeywell expands the capability to give alerting and warning for obstacles in other areas of the world. Obstacles in the database are those known man made obstructions more than 100 feet AGL, so obstacles of lower height cannot produce TAWS obstacle alerts or warnings. TAWS actually produces a terrain alert. The terrain and obstacle database information must be accurate to within 25 feet.

CAUTION

WIRES ARE NOT PRESENTLY INCLUDED IN THE TAWS DATABASE.

As the data becomes available, Honeywell will be adding power lines to the obstacle database. Operators with access to power line data or with unique obstacles within their operational area should contact the Honeywell Database department through the Internet web site at http://www.egpws.com. Runway information in the TAWS computer contains all known public runways with a published IAP. This data is used to adjust the alerting and warning functions of TAWS so as to give a dynamic system that is essentially free of nuisance or unwanted warnings. For a complete list of airports included in the database, please visit our http://www.egpws.com/database website.

Cockpit Warning and Caution Lights

An amber **CAUTION** and a red **WARNING** light is mounted over the pilot and copilot PFD/MFDs. In some cases, a single set of lights are mounted near the center of the glareshield. Two lamp formats are available, however, lamp Format 2 is the most common and used throughout this guide. Both formats are listed in Table 19-1.

Table 19-1
Caution and Warning Formats

Mode/Aural Message	Format 1	Format 2
Mode 1 Sink Rate	**WARNING**	**CAUTION**
Mode 1 Pull Up	**WARNING**	**WARNING**
Mode 2 Terrain Terrain	**WARNING**	**CAUTION**
Mode 2 Pull Up	**WARNING**	**WARNING**
Mode 3 Don't Sink	**WARNING**	**CAUTION**
Mode 4 Too Low Terrain	**WARNING**	**CAUTION**
Mode 4 Too Low Gear	**WARNING**	**CAUTION**
Mode 5 Glideslope	**CAUTION**	**CAUTION**
Mode 6 Call outs	None	None
Mode 6 Bank Angle	None	None
Mode 6 Tail Too Low	None	None
Terrain Caution Terrain	**WARNING**	**CAUTION**
Terrain Warning Terrain	**WARNING**	**WARNING**
Obstacle Caution Warning	**WARNING**	**CAUTION**
Obstacle Warning Obstacle	**WARNING**	**WARNING**

Terrain Inhibit Switch

The TAWS system requires the installation of a terrain inhibit switch. When engaged by the pilot, this switch inhibits the terrain and obstacle alerts and warnings, however, the terrain display remains operational. The purpose of the terrain inhibit switch is to permit aircraft to operate in VFR conditions in areas that are close to high terrain and or in metropolitan areas of high rise buildings. The terrain inhibit switch must NOT be engaged for most normal operations. A timed audio inhibit switch is used as an alternative to this switch.

Timed Audio Inhibit Switch

As an alternative to the terrain inhibit switch, an audio inhibit switch can be installed. This momentary activated switch permits the pilot to turn OFF all TAWS audio warnings for five minutes. Resetting the switch restores the audio immediately. The audio inhibit switch is intended for EMS and SAR operations where the aircraft is operating very close to terrain. Under normal operations, this switch should never be needed. The visual warnings are not inhibited.

Low Altitude Switch

To permit helicopter operations that require low altitude flight, a low altitude function is enabled with a switch. This function is designed for flight at low altitude in VFR conditions. When this function is engaged:

- Mode 1 is inhibited
- Mode 2 warning boundaries are significantly reduced
- Mode 3 warnings are inhibited above 100 feet AGL
- Mode 4 warning boundaries are significantly reduced
- Mode 6 **Altitude Altitude** call out enabled
- Terrain Advisory look ahead distances are reduced.

Low altitude operation is defined as operation below 500 feet AGL. There are other circumstances where the use of the low altitude mode is appropriate. Those include operation in a high-density metropolitan environment with high rise buildings, operation below 1250 feet AGL when the GPS is not operational or is giving poor accuracy. In addition, giving airport maneuvering where airspeeds exceed 50 knots and some IFR offshore platform approach procedures.

CAUTION

THE PILOT MUST MAINTAIN VISUAL CONTACT WITH ALL TERRAIN AND OBSTACLES AT ALL TIMES WHEN USING THE LOW ALTITUDE MODE. THE LOW ALTITUDE MODE MUST NOT BE ENGAGED DURING IFR CONDITIONS. THE LOOK DOWN ANGLE IS REDUCED WITH LOW ALTITUDE ENGAGED. WARNING TIME IS GREATLY REDUCED. NOTED EXCEPTION IS OFFSHORE PLATFORM IFR APPROACHES.

Glideslope Cancel Switch

When an active ILS is being received, TAWS monitors the aircraft position relative to the glideslope and gives the pilot an aural and visual warning if the aircraft descends more than 1.3 dots below the center of the beam. If the pilot is going to intentionally descend below the glideslope, the glideslope cancel switch is used to prevent unnecessary warnings. The glideslope warning rearms when the aircraft climbs above 2000 feet radio altitude, descends below 50 feet or the pilot tunes a frequency other than the active ILS.

Terrain Awareness Display

In addition to showing terrain ahead of the aircraft, the TAWS shows MSL altitude, range in NM, and the elevations of the highest and lowest terrain features shown on the display. Normally, the top of the display is oriented to true heading. When true heading is not available, the display orients to true track. The color and intensity of the terrain displayed instantly alerts the pilot to areas of dangerous terrain and conversely to areas of less precipitous terrain. Range of the terrain display is selectable by the pilot from 2.5 NM to 160 NM.

Auto Range

If an alert occurs and the range is not already set at 5 NM, TAWS automatically changes the range to 5 NM or 10 NM. When the low altitude mode is selected, the range is set to 2.5 NM (or 5 NM or 10 NM). This feature is referred to as auto range.

Pop-Up Mode

When the primary TAWS display is being used for something else, (such as, radar, when an alert is triggered), the display automatically pops up and switches to the TAWS terrain display. This feature is referred to as auto pop-up.

Display Colors

TAWS adjust colors on the terrain display automatically as the aircraft altitude changes. The terrain display transitions between the lower altitude relative display and the higher altitude peaks display automatically, so no pilot action is required.

Figure 19-4 shows the terrain display color patterns when the aircraft is at lower altitudes. These colors vary slightly depending on the type of display.

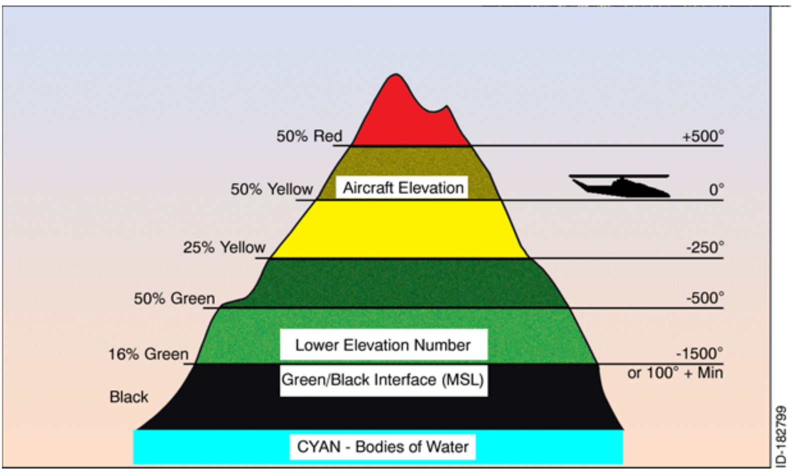


Figure 19-4
Terrain Color Scheme

The most important function of the TAWS is to give the pilot easy interpreted information about terrain/obstacles relative to the aircraft, and increase the situational awareness for the pilot. In general, the normal presentation of green, yellow and red colors, as listed in Table 19-2, indicate the following:

Table 19-2
Color Indications

GREEN colors	Terrain/Obstacles are below the aircraft altitude. Safe terrain/ obstacle clearance is indicated.
YELLOW colors	Terrain is very near or above the aircraft altitude. **The aircraft may not have safe terrain clearance.**
RED colors	Terrain is well above the aircraft altitude (at least 500 feet higher) **The aircraft may not be able to escape this terrain.**

Peaks Mode

Peaks mode refers to the style of the terrain display when the aircraft is more than 250 feet above all terrain in the display area. It is a combination of up to three green shades that permits the pilot to see where terrain features are, such as valleys and mountain tops, that are below the aircraft. Table 19-3 outlines all the various colors used by the TAWS terrain display and their function in giving situational awareness to the pilot.

Table 19-3
Terrain Color

Color	Indication
Solid Red	Terrain/obstacle threat area warning.
Solid Yellow	Terrain/obstacle threat area caution.
50% Red Dots	Terrain/obstacle that is more than 500 feet above aircraft altitude.
50% Yellow Dots	Terrain/obstacle that is between aircraft altitude and 500 feet above.
25% Yellow Dots	Terrain/obstacle that is between aircraft altitude and 250 feet below.
Solid Green	Shown only when no red or yellow terrain/obstacle areas are within (peaks only) range on the display. Highest terrain/obstacle not within 250 feet of aircraft altitude.
50% Green Dots	Terrain/obstacle that is 250 feet below to 500 below aircraft altitude (peaks only). Terrain/obstacle is the middle elevation band when there is no red or yellow terrain areas within range on the display.

Table 19-3 (cont)
Terrain Color

Color	Indication
16% Green Dots	Terrain/obstacle that is 500 to 1500 feet below aircraft altitude (peaks only). Terrain/obstacle that is the lower elevation band when there is no red or yellow terrain areas within range on the display.
Black	No significant terrain/obstacle.
16% Cyan	Area having sea level elevation (0 feet MSL).
Magenta Dots	Unknown terrain. No terrain data in the database for the magenta area shown.

On the terrain display, an indication of MSL altitude appears. This altitude is the reference altitude for the display and the terrain awareness algorithm. This reference altitude is based on internally calculated geometric altitude and NOT corrected barometric altitude. It represents the calculated true height above sea level (MSL) and serves as the reference altitude for color coding of the terrain display and the altitude input to the look-ahead algorithm.

Since it is primarily comprised of GPS altitude, this reference altitude often differs from cockpit displayed corrected barometric altitude. This altitude is not to be used for navigation. It is presented to give the crew additional situational awareness of true height above sea level, upon which terrain alerting and display is based.

Cell Expansion

When flying with the range set at greater than 10 NM, it can be difficult using the display to determine where a nearby threat is relative to the aircraft. This is due to the size of the threat versus the amount of terrain displayed. To relieve this problem, the TAWS increases the size of the grids that contain an obstacle or terrain threat. This feature is called cell expansion. Cell expansion is not used when the display range is less than or equal to 10 NM.

Look-Ahead Alerting and Warning

Using aircraft position, altitude, and flight path information, TAWS gives an envelope of protection for the aircraft that is independent from the terrain awareness display. This look-ahead function compares the aircraft flight path to terrain and obstacle database information, and distance to known runways.

General representation of the look-ahead functionality is shown in Figure 19-5.

When the look-ahead function detects a terrain or obstacle threat approximately 30 seconds ahead of the aircraft, the aural alert **CAUTION TERRAIN**, **CAUTION TERRAIN** (or **CAUTION OBSTACLE, CAUTION OBSTACLE**) is given, and a bright, solid yellow threat area is shown on the terrain display. Should the aircraft flight path continue toward the threat area, the alert message would repeat approximately every seven seconds.

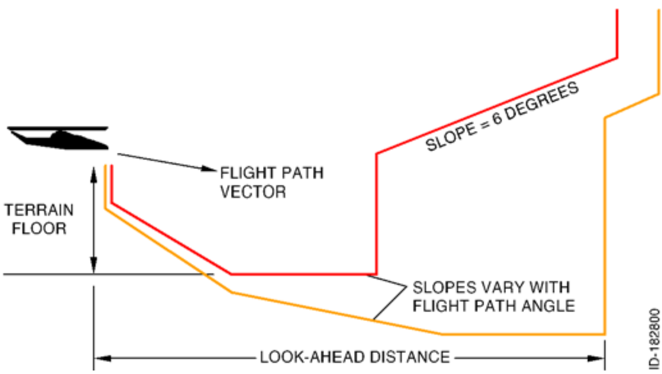


Figure 19-5
Look Ahead

When the aircraft flight path approaches to within approximately 20 seconds of a threat area, the aural message **WARNING TERRAIN, WARNING TERRAIN** (or **WARNING OBSTACLE, WARNING OBSTACLE**) is given continuously and the threat area on the terrain display is shown in a bright, solid red color.

GPS signal quality, low altitude mode and rate and direction of turn modify the look-ahead envelope. TAWS uses turn rate and direction to predict the aircraft flight path in the turn and looks around the corner for terrain/obstacles. Forward airspeed modifies the look-ahead envelope. Below 100 knots, the envelope is reduced until it is completely inhibited at 70 knots or less. The preceding speeds are for fast helicopter configurations, slow configurations use the range 90 knots to 60 knots for envelope reduction.

Terrain Failure

Failure of the terrain awareness functions results in a TERR INOP annunciator and the aural message **BE ALERT TERRAIN INOP**. This can happen when GPS shadowing occurs during turns and/or flight in mountainous terrain.

Non-Database Modes

Figure 19-6 shows the six modes that give a warning not associated with the map or the database.

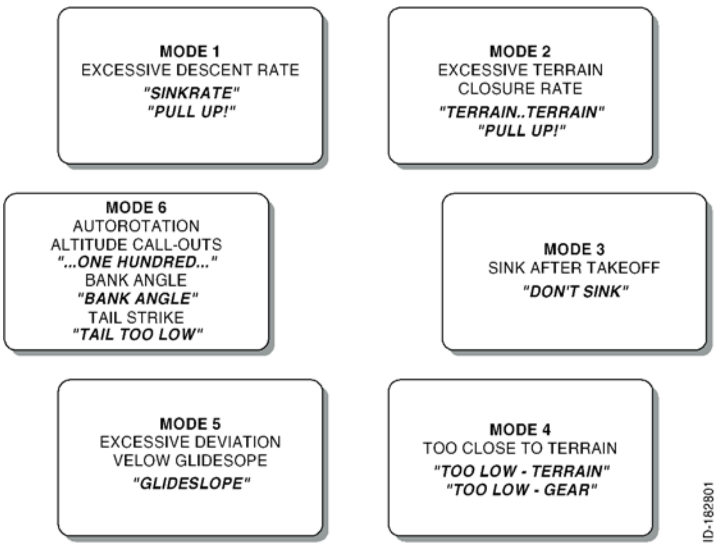


Figure 19-6
Warning Modes

MCDU TAWS Operation

Figure 19-7 shows the MENU 1/2 page on the MCDU.

Figure 19-7
MCDU MENU 1/2 Page

Pushing LSK 1L on the MCDU MENU 1/1 page, shows the TAWS 1/1 page, shown in Figure 19-8.

The following options are selected from the TAWS 1/1 page, shown in Figure 19-8, using the MCDU:

- LOW ALT – ON/OFF
- G/S CANCEL – ON/OFF
- TERR INHIBIT – ON/OFF
- MUTE – ON/OFF.

Figure 19-8
MCDU TAWS 1/1 Page

TAWS Test

From the MENU 1/1 page, the TAWS test is accessed by selecting the TEST page, by pushing the LSK 3R on the TEST 1/1, as shown in Figure 19-9.

Figure 19-9
MCDU With TAWS Self-Test Active

Pushing the TAWS test button starts the test cycle and shows a TAWS test screen. When the test is complete, the test display reverts to the original TAWS screen. This test does not require crew intervention to exit the cycle, as it turns itself OFF automatically.

GROUND TESTING

The TAWS self-test go/no go test is normally performed by the flight crew as part of preflight checks.

The self-test is used to verify proper operation of the TAWS on the ground as follows:

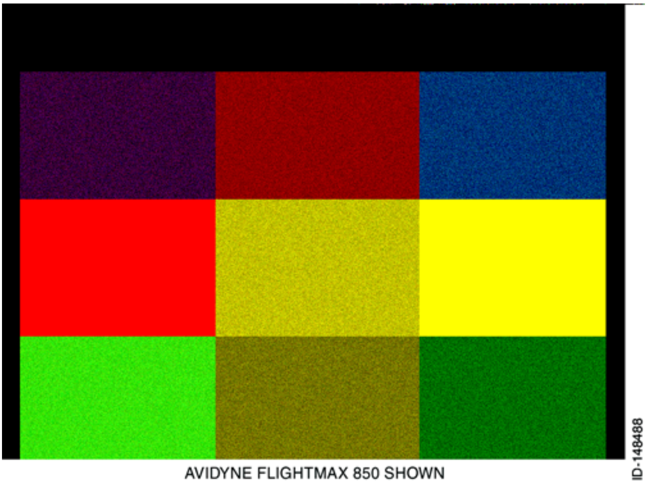
1. Verify adequate aircraft power is available and the TAWS and associated systems are powered.

2. Verify any TAWS inhibiting switches are in the normal (noninhibiting) position.

3. Verify TAWS inoperative annunciators are extinguished. If an inoperative annunciator is indicated, perform the TAWS self-test (see Step 5) and then seek corrective action, if the inoperative condition persists.

4. Select terrain to be displayed.

5. When a self-test is initiated, the test continues through a sequence resulting in turning ON and OFF all system annunciators, broadcasting specific audio messages, and if enabled, displaying a video test pattern on the terrain display, as shown in Figure 19-10. Any functions determined inoperative are broadcast, (for example, GLIDESLOPE INOP). When self-test is completed, it terminates automatically.



AVIDYNE FLIGHTMAX 850 SHOWN

Figure 19-10
TAWS Test Pattern

The following is a description of the expected results of a typical terrain self-test annunciators displayed on the MFD. Actual annunciator nomenclature and sequence can differ depending on the installation.

- GPWS INOP, W/S INOP, and TERR INOP annunciators turn ON.
- GPWS INOP, W/S INOP, and TERR INOP annunciators turn OFF.

- **GND PROX** annunciator turns ON.
- GLIDESLOPE is announced over speaker.
- **GND PROX** annunciator turns OFF.
- **PULLUP** annunciator is displayed.
- PULL UP is announced over speaker.
- **PULLUP** annunciator turns OFF.
- Warning (**PULLUP**) annunciator turn ON.
- TERRAIN, TERRAIN, PULL UP is announced over speaker.
- Terrain test pattern is displayed (as shown in Figure 19-10).
- **PULLUP** annunciator turns OFF.
- Terrain test pattern is turned OFF.

6. Verify expected indications and annunciators during test, repeating as necessary noting any erroneous conditions.

SYSTEM DESCRIPTION

The TAWS uses input signals from other onboard systems, as shown in Figure 19-11. Systems that monitor altitude, airspeed, attitude, glideslope, and position are required for both the basic and enhanced versions of TAWS. Inputs are required for discrete signal and control input.

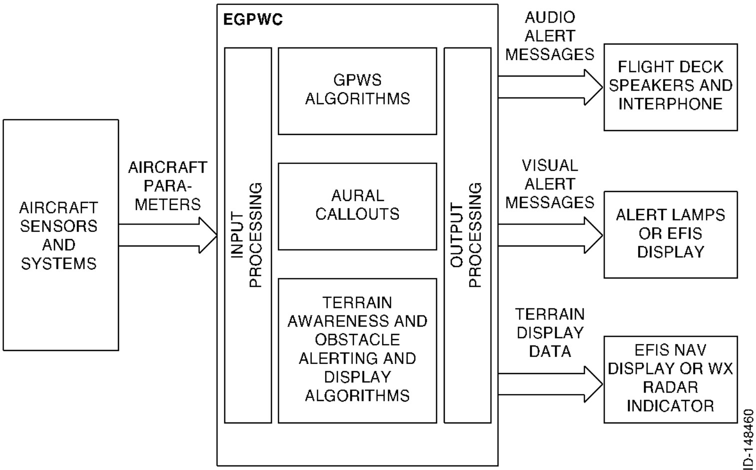


Figure 19-11
System Diagram

The TAWS uses signals from the following systems:

- Air data
  - — Uncorrected and corrected barometric altitude
  - — Altitude rate
  - — Computed airspeed
  - — True airspeed
  - — Static air temperature are given by air data system
  - — Radio altitude is given by a radio altitude system.
- Radio altitude system (or ancillary system)
  - — Decision height
  - — Decision height altitude.

TAWS conducts radio altitude reasonableness checks based on the computed terrain clearance. Computed terrain clearance is computed by subtracting the elevation of the (database) terrain below the aircraft from geometric altitude (ASL). Radio altitude is considered unreasonable when it indicates a terrain clearance that is less than the computed terrain clearance by more than 2000 ft. For example, if the computed terrain clearance is 10,000 ft and the radio altitude is any value (0-2500 ft), the radio altitude is considered unreasonable. This is only performed when TAD is enabled, high integrity terrain and position data are available, and the computed terrain clearance is greater than 4000 ft. This feature reduces the potential for nuisance alerts as a result of false tracking of the radio altitude.

Other system outputs are listed below:

- FMS, IRS, attitude and heading reference system (AHRS), and accelerometers output
  - — Pitch and roll attitude
  - — Latitude and longitude position
  - — Body normal and longitudinal accelerations
  - — Magnetic and true track angles
  - — Magnetic and true heading
  - — Inertial altitude
  - — Ground speed
  - — Type.
- Global positioning system
  - — Latitude and longitude position
  - — True track angle
  - — GPS altitude

- Ground speed
- Horizontal and vertical figure of merit (HFOM/VFOM)
- Horizontal integrity limit (HIL)
- Sensor status.

- VHF NAV receiver
  - Glideslope
  - Localizer
  - ILS tuned
  - Selected runway heading
  - Display range.
- Angle-of-attack (AOA) vane or stall warning
  - AOA
  - Stick shaker margin.

TAWS APM options are used to tell the system the type of aircraft and interface that it is on. These are defined and established during the TAWS installation. TAWS output functions are the result of APM options read each time the TAWS is powered ON. APM options include:

- Decision height
- Terrain display range
- Status discretes such as glideslope valid, localizer valid, radio altitude valid associated with analog signal inputs.

Control discretes control TAWS functions. These include:

- TAWS test
- Glideslope cancel
- Glideslope inhibit or glideslope backcourse
- Terrain (display) select
- Terrain inhibit
- Flap override
- Audio inhibit
- Altitude callout enable
- Steep approach enable
- ILS tuned discretes.

TAWS System Outputs

The TAWS gives both audio and visual outputs.

Audio outputs are sent as specific alert phrases, and altitude callouts or tones are sounded by the speaker, and by the cockpit interphone system for use in the headset. Audio output levels are established during the installation of the TAWS. These TAWS audio outputs can be inhibited by other systems that have a higher priority (such as, windshear), or using cockpit switches. The TAWS audios can inhibit other system audio outputs such as TCAS.

Visual outputs give discrete alert and status annunciators, and display terrain video when a compatible display system is installed. The discrete visual alerts coincide with audio caution and warning alerts to maximize the terrain alerting capability. Status annunciators tell the pilot about the status of the TAWS (such as, GPWS INOP) or if other functions have been selected.

Terrain video is generated by the TAWS based on the current aircraft position relative to the surrounding terrain. This video is displayed on a weather radar indicator, EFIS display, or a dedicated display unit.

TAWS INSTALLATION ON THE AGUSTA AW139/AB139 AIRCRAFT

TAWS on the MFD

Terrain mapping can be overlaid on the HSI with or without FMS map display, when the compass display is in the arc mode and TAWS has been selected for display using the display controller

The terrain mode annunciators are displayed directly below the WX mode annunciator in the lower left corner of the PFD. The terrain mode annunciators are displayed on two lines. The first line contains the terrain mode. The second line is located below the first and contains peaks information.

On the MFD, displaying TAWS is a pilot option. The **TAWS** button on the MFD menu, shown on the next page, is an exclusive button. If weather is being displayed and the pilot selects the **TAWS** button, weather is removed from the screen and the TAWS display replaces it.

- **TAWS Button** – When the **TAWS** button is selected, terrain information from the TAWS is displayed on the MAP page with the flight plan is superimposed over the terrain display, as shown in Figure 19-12.

Figure 19-12
TAWS Displayed on the MFD

PFD TERRAIN ANNUNCIATORS

Terrain, shown in Figure 19-13, is selected for display on the PFD using the display controller **WX/TERR** button.

- **WX/TERR (Weather Radar/TERR) Control Button** – Pushing the

WX/TERR button toggles the HSI display in the following sequence:

☞ WX ON ☞ TERR ON ☞ WX/TERR OFF

Like the **MAP** button, pushing the **WX/TERR** button automatically selects the arc mode for the HSI.

NOTE: If WX or TAWS is not installed but is selected, the **NO WX/TAWS INSTAL** CAS message is displayed for 5 seconds. **NO WX/TAWS INSTAL** is also displayed if the WX/TAWS button is pushed when weather radar or TAWS is installed but the function is not available for display on the PFD.

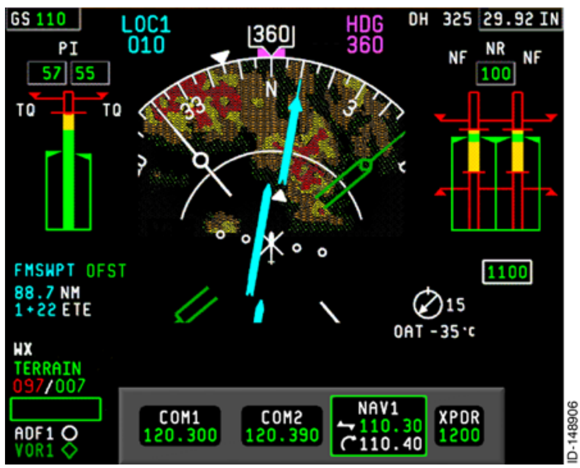


Figure 19-13
TAWS Displayed on the PFD

The terrain annunciators are displayed directly below the WX mode annunciators in the lower left corner of the PFD. The terrain annunciators are displayed on two lines. The first line contains the terrain mode. The second line contains peaks information. There are four mode annunciators:

- **TERRAIN** – Terrain selected
- **TAWS INHIBIT** – Terrain display override selected from the MCDU TAWS page
- **TERR N/A** – Terrain not available

- **RNG MISMATCH** – Miscompare between MFD range and TAWS range.

When terrain is selected for display and the video data is lost, **TERR** is displayed on the half-range ring.

PEAKS INFORMATION

Peaks information is calculated by the TAWS. It is displayed as a digital readout directly below the terrain mode annunciator. The data shows two elevation numbers that indicate the highest and lowest terrain currently being displayed. The elevation numbers indicate terrain in hundreds of feet above mean sea level (MSL). The terrain elevation numbers are displayed with the highest terrain number first, and a (/) with the lowest terrain number next, (such as, 144/085 might be displayed as 144/085).

The highest terrain number is the same color as the highest terrain color pattern on the terrain display. It is shown in white when the digital value is 000 . The lowest terrain number is the same color as the lowest terrain color pattern on the display. It is **black** (such as, blank) when flying over water or relatively flat terrain (no appreciable difference in terrain elevations). If peaks information is lost, the peaks display shows amber dashes in the format (– – – /– – –).

NOTE: Color nomenclature for TAWS is described in detail throughout the rest of this section.

TAWS Database

The TAWS internal database consists of four subsets:

1. A worldwide terrain database of varying degrees of resolution.
2. An obstacles database containing cataloged obstacles 100 ft or greater in height located within North America and portions of the Caribbean (expanding as data is obtained).
3. A worldwide airport database containing information on hard-surface runways 3500 ft or longer in length. For a specific list of the airports included, refer to Honeywell document 060-4267-000 or access on the Internet at website www.egpws.com.
4. An envelope modulation database to support the envelope modulation feature.

All of these databases are constantly updated. Notification of a database update is done using service bulletins. Database updates are distributed on CD and are downloaded by the data loading system (DLS).

Because the majority of controlled flight into terrain (CFIT) accidents occur near an airport, and the fact that aircraft operate in close proximity to terrain near an airport, the terrain database contains higher resolution grids for airport areas. Lower resolution grids are used outside airport areas where aircraft en route altitude make CFIT accidents less likely and terrain feature detail is less important to the flight crew.

The TAWS receives present position, track, and ground speed from the FMS or GPS. With this information, the TAWS is able to show a graphical plan view of the aircraft relative to the terrain and advise the flight crew of a potential conflict with the terrain or obstacle. Conflicts are recognized and alerts sounded when terrain violates specific computed envelope boundaries on the projected flight path of the aircraft. Alerts can be in the following form:

- Visual light annunciator of a caution or warning
- Audio annunciation based on the type of conflict
- Color enhanced visual display of the terrain or obstacle relative to the forward look of the aircraft.

The terrain display is shown on the weather radar indicator, EFIS display, or a dedicated TAWS display and may or may not be displayed automatically. The sections that follow describe functions of the TAWS basic and enhanced features, and system input and output requirements.

Altitude Alerting

The altitude alerting function is controlled by the monitoring warning system (MWS). The altitude alerts are provided when the RHT or ALT flight director mode is engaged and the aircraft deviates from the target altitude.

NOTE: The ALT flight director mode can be engaged on the pitch or collective axis. The RHT flight director mode can be engaged on the collective axis.

The MWS receives the ALT and RHT reference on the ASCB from the priority flight director. The altitude alert function sources the barometric or radio altitude from the source selected for display on the coupled PFD.

ALTITUDE ALERTING OPERATION

At system power-up the altitude alert function is initialized to the **off** state. Altitude alerting transitions to the **off** state when the priority flight director does not have ALT or RHT flight director modes engaged. The altitude alert function remains in the **off** state until the conditions to transition to a **standby** state is satisfied.

When in the **off** state, no alerts can occur and the MWS removes any existing alerts. Altitude alerting transitions to the **standby** state when either of the following occurs:

- When the RHT or ALT flight director mode has transitioned from not engaged to engage by the priority flight director.
- When the RHT flight director mode is engaged and the RHT reference has changed.
- When the ALT flight director mode is engaged and the ALT reference has changed.

The altitude alert function remains in the **standby** state until the conditions to transition to the **off** or **armed** states are satisfied. For example, the altitude alert function cannot transition from standby to active. When in the **standby** state, no alerts can occur and the MWS removes any existing alerts.

Altitude alerting transitions to the **armed** state when a previous state was **active** or **standby** and either of the following occurs:

- The RHT flight director mode is engaged and absolute [current radar altitude - RHT reference] < [2+0.125*RHT reference] feet.
- The ALT flight director mode is engaged and absolute [current baro altitude - ALT reference] < 130 feet.

The altitude alert function remains in the **armed** state until the conditions to transition to the **off**, **standby**, or **active** states are satisfied. When in the **armed** state, no alerts can occur and the MWS removes any existing alerts.

The altitude alerting transitions to **active** state when a previous state was **armed** and either of the following occurs:

- The RHT flight director mode is engaged and absolute [current radar altitude - RHT reference] > [7+0.125*RHT reference] feet.
- The ALT flight director mode is engaged and absolute [current baro altitude - ALT reference] > 150 feet.

The altitude alert function remains in the **active** state until the conditions to transition to **off**, **standby**, or **armed** states are satisfied. When the RHT flight director mode is engaged and the altitude alert function is in an **active** state, both the RHT reference bug and the RHT reference digital readout are displayed in amber on both PFDs. When the ALT flight director mode is engaged and the altitude alert function is in an **active** state, the ALT reference bug is displayed in amber on both PFDs. ALTITUDE ALTITUDE aural displayed once when the altitude alert function transitions from the **armed** to **active** state.

TAWS Displays

The description following paragraphs are a detailed look at all of the capabilities of the TAWS. Figure 19-13 shows a TAWS display on the HSI portion of the PFD. The figures shown in the rest of this section show variations the pilot sees during various flight conditions.

GROUND PROXIMITY WARNINGS AND CAUTIONS

Ground proximity warning and caution messages are displayed in the lower left corner of the ADI using the following priority, from highest to lowest, to determine which annunciator is displayed if more than one is active:

- PULL UP (ground proximity warning OR terrain/obstacle awareness warning)
- GND PROX (ground proximity caution OR terrain/obstacle awareness caution).

When a ground proximity warning is indicated, a PULL UP annunciator is displayed on the ADI. The PULL UP annunciator toggles reverse video one second ON and .5 second OFF (PULL UP) for the first six seconds. The annunciator is displayed as steady PULL UP. The annunciator is removed when a ground proximity warning is no longer indicated.

When a ground proximity caution is indicated, a GND PROX annunciator is displayed on the ADI. The GND PROX annunciator toggles reverse video one second ON and .5 second OFF (GND PROX) for the first six seconds. The annunciator is then displayed as steady GND PROX. The annunciator is removed when a ground proximity caution is no longer indicated.

A loss of valid TAWS information inhibits the PULL UP, GND PROX annunciators and TAWS FAIL is annunciated.

TAWS STATUS ANNUNCIATORS

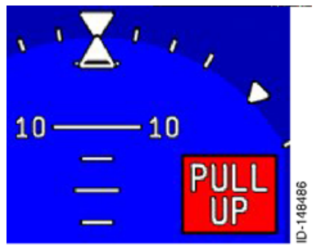
The following TAWS status annunciator is displayed in the lower left corner of the ADI. When TAWS indicates a functional test, a TAWS TEST annunciator is displayed. The TAWS self-test can be selected from the MCDU test page.

When TAWS indicates a terrain fail condition, TAWS FAIL is displayed. When TAWS indicates a terrain awareness function is inoperative, the TAWS INOP annunciation is displayed. The TAWS status annunciators are all located in the same area as the warnings and cautions, using the following priority from highest to lowest TAWS TEST, TAWS FAIL, TAWS INOP, and warning and caution annunciators. The TAWS status annunciators are displayed when TAWS is installed in the aircraft.

OTHER TAWS DISPLAYS

- **TAWS Displays** – Visual messages are displayed on the PFD to accompany aural messages generated by the TAWS for ground proximity conditions. Ground proximity is annunciated on the ADI and initially flashes for five seconds then remains ON until the condition is no longer detected.

Caution Advisory



Warning Advisory

Ground Proximity

The TAWS incorporates the functions of the basic GPWS. This includes the following alerting modes:

Mode 1 – Excessive descent rates with **SINK RATE** and **PULL UP** aural warnings.

Mode 2 – Excessive terrain closure rates with **TERRAIN, TERRAIN** and **PULL UP** aural warnings.

Mode 3 – Altitude loss after takeoff with **DON'T SINK, DON'T SINK** aural warning.

Mode 4 – Unsafe terrain clearance with **TOO LOW TERRAIN** aural warnings.

Mode 5 – Excessive deviation below glideslope with a **GLIDESLOPE** aural warning.

Mode 6 – Advisory callouts with **BANK ANGLE**, **MINIMUMS**, and selected altitudes aural warnings.

Mode 1 Excessive Descent Rate

Mode 1 alerts for excessive descent rates with respect to altitude AGL are active for all phases of flight. This mode has inner and outer alert boundaries, as shown in Figure 19-14 diagram and graph.

TAWS uses altitude rate from the air data computer and radio altitude to detect when the aircraft is descending toward terrain at a high rate for its relative altitude above terrain.

TAWS gives alerting and warning to the pilot. Initially, the voice alert **SINK RATE** is heard, and the amber caution alert **GND PROX** is annunciated on the PFD. If the aircraft continues in the high rate of descent, the **SINK RATE, SINK RATE** aural alert is repeated at an increasing frequency. Should the aircraft penetrate the warning boundary, the aural alert **PULL UP** is heard continuously and the red warning **PULLUP** is annunciated on the PFD. In both cases, as the pilot reacts to decrease the high rate of descent and the aircraft flight path exits the alerting/warning envelope, the annunciator lamp extinguishes and the aural alerts cease.

Sometimes, the alerting and warning functionality for excessive rate of descent is overridden by the terrain look-ahead functionality. This is normal as the look-ahead function has a higher priority in the TAWS alerting/warning logic.

Mode 1 is inhibited during a detected autorotation on aircraft with a torque input or when low altitude is selected. The Mode 1 aurals are inhibited during a timed audio inhibit.

NOTE: The **PULL UP** audio message can be preceded by a Whoop, Whoop sound in some configurations based on the audio menu option selected.

If a valid ILS glideslope front course is received and the aircraft is above the glideslope centerline, the outer (sinkrate) boundary is adjusted to desensitize the sinkrate alerting. This prevents unwanted alerts when the aircraft is safely capturing the glideslope (or repositioning to the centerline) from above the beam.

The TAWS offers a steep approach option for some aircraft types that desensitizes the alert boundaries to permit steeper than normal approaches without unwanted alerts.

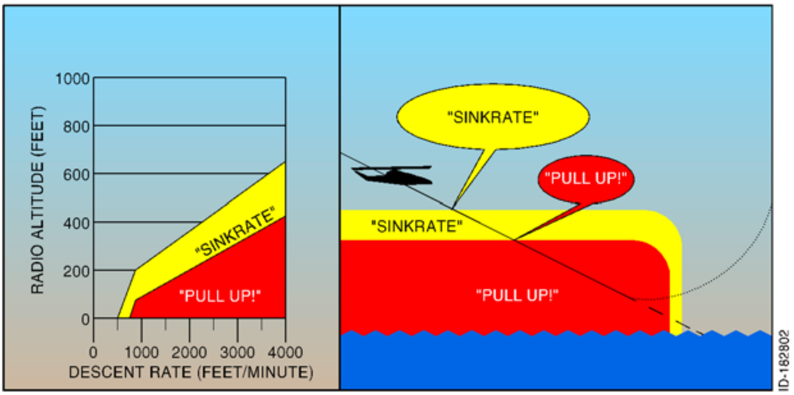


Figure 19-14
Mode 1 Diagram and Graph of Boundaries

Mode 2 Excessive Closure to Terrain

Mode 2 gives alerts when the aircraft is closing with the terrain at an excessive rate. It is not necessary for the aircraft to be descending in order to produce a Mode 2 alert. Level flight (or even a climb), towards obstructing terrain can result in hazardous terrain closure rate. The terrain closure rate variable is computed within the EGPWS computer by combining radio altitude and vertical speed.

Mode 2 has two submodes, referred to as Mode 2A and Mode 2B, the active submode being determined by aircraft configuration and airspeed. Mode 2 uses an integrity view, which indicates how well terrain awareness, display, and geometric altitude functions are performing in conjunction with the terrain data integrity. When these conditions are satisfied, Mode 2 functions are inhibited. Mode 2 is inhibited by the low altitude mode and during autorotation. The Mode 2 aurals are inhibited during a timed audio inhibit.

MODE 2A ALERTS

Mode 2A is enabled when the conditions for enabling Mode 2B are not satisfied. If the aircraft penetrates the Mode 2A alerting envelope, shown in Figure 19-15, the aural message **TERRAIN, TERRAIN** is generated initially, and the amber caution **GND PROX** is annunciated on the PFD. If the aircraft continues to penetrate the envelope, the aural message **PULL UP** is repeated continuously and the red warning **PULLUP** is annunciated on the PFD, until the warning envelope is exited. As shown in Figure 19-15, the upper boundary of the Mode 2A alert envelope varies as a function of aircraft speed. As airspeed increases from typically 90 knots to 130 knots, the boundary expands to give increased alert times at higher airspeeds. Expansion airspeeds are varied for some aircraft types.

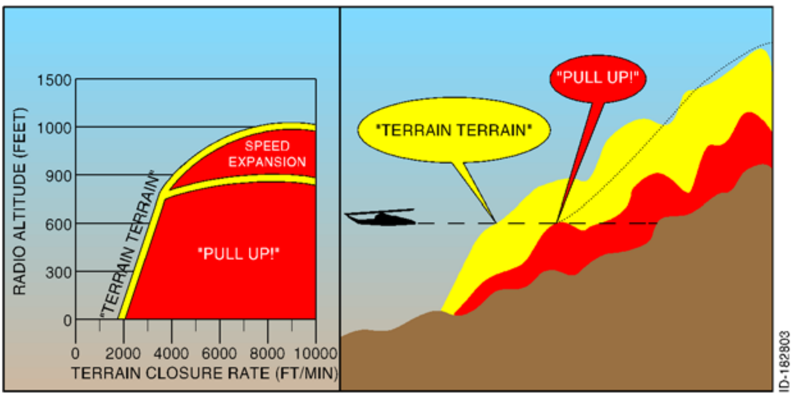


Figure 19-15
Mode 2A Alerts

MODE 2B ALERTS

Mode 2B gives a desensitized alert envelope, permitting normal landing approach maneuvering close to the terrain without producing unwanted alerts. Mode 2B is enabled for three conditions:

- When the landing gear is down or for fixed gear aircraft
- When less than 80 knots and less than 200 ft AGL
- When the aircraft is performing an ILS approach and is within two dots of the glideslope centerline
- For the first 60 seconds after takeoff.

Mode 2 alerts help protect the aircraft from impacting the ground when rapidly rising terrain with respect to the aircraft is detected, as shown in Figure 19-16. Mode 2 is based on radio altitude and on how rapidly radio altitude is decreasing (closure rate). Mode 2 exists in two forms, 2A and 2B.

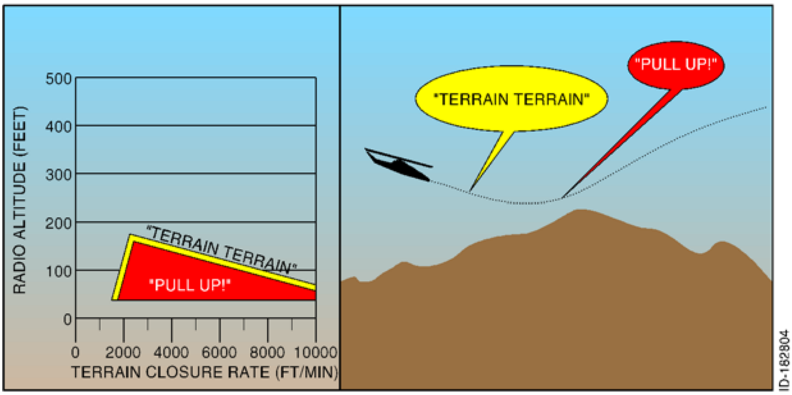


Figure 19-16
Mode 2B Alerts

NOTE: The **PULL UP** audio message can be preceded by a Whoop, Whoop sound in some configurations based on the audio menu option selected.

Mode 3 Altitude Loss After Takeoff

Mode 3 gives alerts when the aircraft loses a significant amount of altitude immediately after takeoff or during a missed approach. Mode 3 is enabled after takeoff or go-around when landing gear is not in a landing configuration, or when the airspeed is greater than 50 knots. The mode stays enabled until the EGPWS computer detects that the aircraft has gained sufficient altitude that it is no longer in the takeoff phase of flight which in normal conditions is about 60 seconds.

The altitude loss variable is based on the altitude value from the time of the beginning of the inadvertent descent. The amount of altitude loss, which is permitted before an alert is given, is a function of the height of the aircraft above the terrain and the length of time since takeoff.

If the aircraft penetrates the Mode 3 boundary, the aural message **DON'T SINK, DON'T SINK** is generated and the amber caution **GND PROX** is annunciated. The visual annunciators remain active until a positive rate of climb is re-established. Figure 19-17 shows this alerting envelope.

As the pilot adjusts the flight path of the aircraft and a positive rate of climb is re-established, the voice alert **DON'T SINK** ceases and the amber caution annunciator **GND PROX** extinguishes. Mode 3 aurals are inhibited while the timed audio inhibit is active.

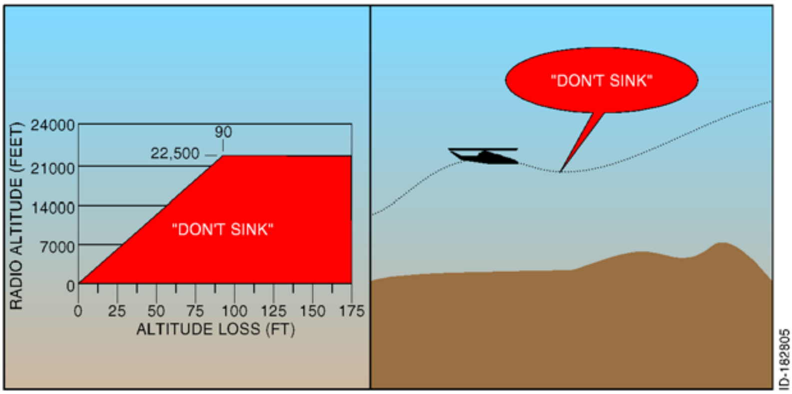


Figure 19-17
Mode 3 Alert

NOTE: To prevent nuisance **DON'T SINK** warnings while maneuvering around an airport where airspeeds exceed 50 knots, it is recommended that the low altitude mode be selected.

Mode 4 Unsafe Terrain Clearance

Mode 4 gives alerts for insufficient terrain clearance with respect to phase of flight and airspeed. Mode 4 exists in three forms, 4A, 4B, and 4C.

- Mode 4A is active during cruise and approach with the gear not in landing configuration.
- Mode 4B is active in cruise and approach, but with the gear in landing configuration.
- Mode 4C is active during the takeoff phase of flight with the gear not in landing configuration.

The amber caution **GND PROX** is annunciated during all Mode 4 warnings. Mode 4 aurals are inhibited while the timed audio inhibit is active.

MODE 4A ALERTS

The standard boundary for Mode 4A is at 150 feet radio altitude, as shown in Figure 19-18. If the aircraft penetrates this boundary with the gear still up and less than 100 knots, the aural message is **TOO LOW GEAR**. Above 100 knots the aural message is **TOO LOW TERRAIN**. During an autorotation the gear warning boundary is raised to 400 feet AGL and the **TOO LOW TERRAIN** speed region is removed. Fixed, non-retractable landing gear aircraft do not give Mode 4A.

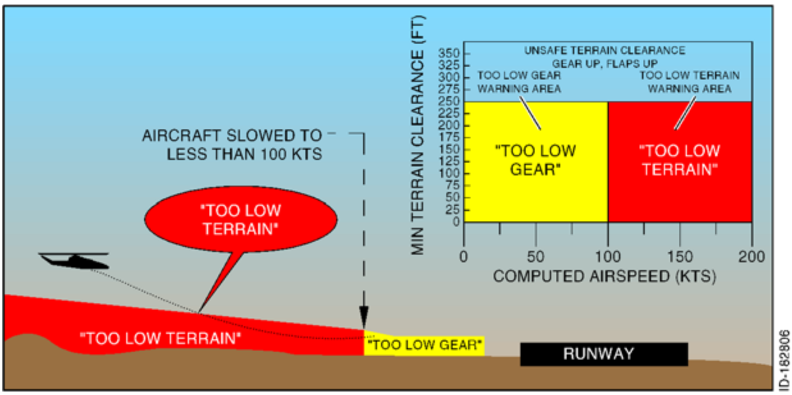


Figure 19-18
Mode 4A Alert Envelope

MODE 4B ALERTS

When the landing gear is lowered, Mode 4B becomes active and the boundary decreases to 100 feet when above 120 knots (100 knots for fixed gear). As airspeed decreases below 120 knots (100 knots for fixed gear), the warning boundary decreases to 10 feet at 80 knots. The aural message is **TOO LOW TERRAIN**, as shown in Figure 19-19.

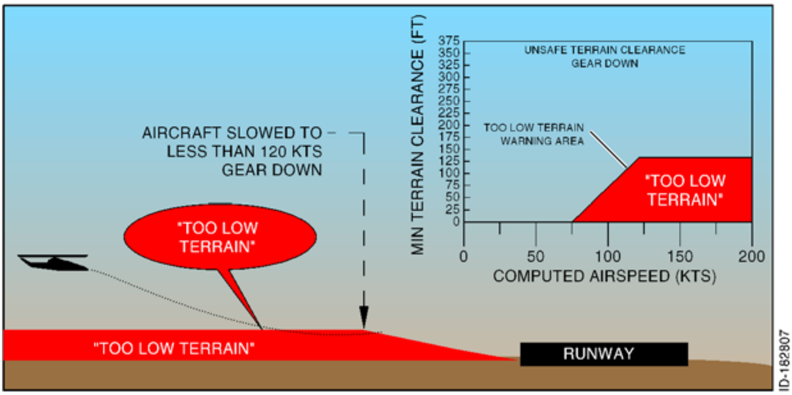


Figure 19-19
Mode 4B Alert Envelope

MODE 4C ALERTS

Mode 4C is based on a minimum terrain clearance, or floor, that increases with radio altitude during takeoff. A value equal to 75 % of the current radio altitude is accumulated in a long-term filter. Any decrease of radio altitude below the filter values with the gear up or airspeed greater than 50 knots results in the warning **TOO LOW TERRAIN**, as shown in Figure 19-20.

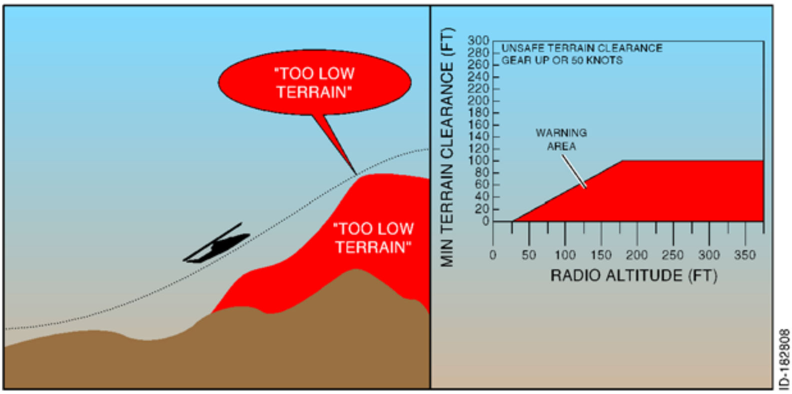


Figure 19-20
Mode 4C Alert Envelope

NOTE: The **GND PROX** annunciator goes out and aural messages stop when the Modes 4A, 4B, and 4C alert envelopes are exited.

Mode 5 Excessive Deviation Below Glideslope Alert

Mode 5 gives two levels of alerting when the aircraft flight path descends below the glideslope beam on front course ILS approaches with the gear down. The first alert **GLIDESLOPE** occurs when the aircraft is more than 1.3 dots below the beam and is called a **soft** glideslope alert. That is because the volume level of the glideslope alert is approximately one half (-6 dB) that of the other alerts.

On a normal approach where the aircraft is established on the glideslope prior to reaching 1000 feet AGL, the upper warning boundary is 1000 feet AGL. However, as long as the aircraft is in level flight, the upper boundary is set at 500 feet AGL. The upper boundary increases linearly to 1000 feet AGL as descent rate raises from 0 to 500 fpm or greater. This permits intercepting the glideslope at less than 1000 feet AGL without getting nuisance warnings.

A second alert **GLIDESLOPE, GLIDESLOPE** occurs below 300 feet radio altitude with greater than 2-dot deviation and is called **loud** or **hard** glideslope alert because the volume level is increased to that of the other alerts.

NOTE: The amber caution **GND PROX** is lit during both soft and hard glideslope alerts.

Mode 5 is enabled when all of the following are present:

- ILS selected with valid GS signal (flag not in view)
- Valid radio altitude less than 1000 ft AGL
- Landing gear down (retractable gear helo only)
- Glideslope cancel is off.

The EGPWS computer must be sensing it is in the approach mode (not Takeoff) or the ground speed is less than 40 kts with the above conditions met.

The localizer signal is used to enable envelope modulation to prevent nuisance warnings at certain airports. The **GLIDESLOPE** aural is inhibited while the timed audio inhibit is active, as shown in Figure 19-21.

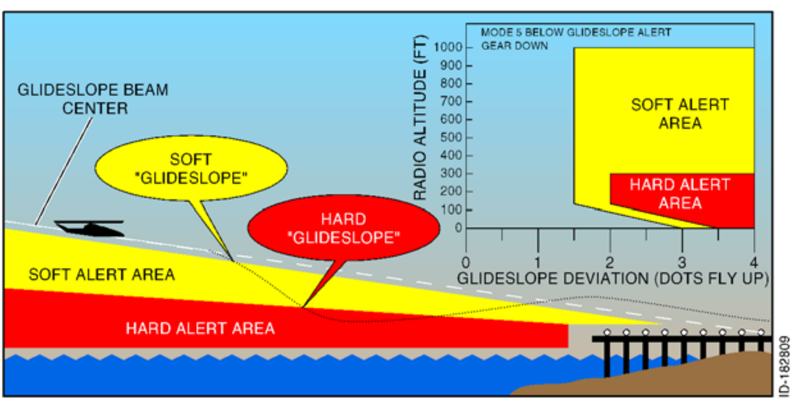


Figure 19-21
Mode 5 Alert Excessive Glideslope Deviation

Mode 6 Altitude Callouts

Mode 6 gives aural callouts for descent below predefined altitudes and minimums. No caution or warning lights are lit. The actual callouts are selected from a menu at installation time.

A **MINIMUMS, MINIMUMS** callout, shown in Figure 19-22, is given based upon the decision height discrete with the landing gear down or less than 90 knots in fixed gear aircraft. When low altitude is selected or gear is up or greater than 90 knots in fixed gear aircraft the message **ALTITUDE, ALTITUDE** is given when transitioning below the selected decision height.

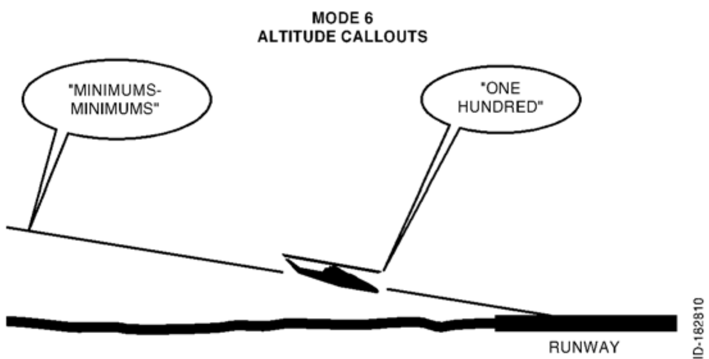


Figure 19-22
Mode 6 Altitude Callout

An optional discrete input gives the ability to force the Mode 6 audio level to lower audio volume. This enables operators to control the Mode 6 volume level with activation of windscreen rain removal or when lower volume callouts are desired at all times.

TAWS AURAL ALERTS

The TAWS computer generates various aural alerts, listed in Table19-4, based on the conditions specified in the EGPWS. TAWS alerts can occur simultaneously with the EICAS aural alerts, though they are prioritized above TCAS aural alerts and inhibit the TCAS aural alerts by way of the audio inhibit discrete output.

Table 19-4
TAWS Aural Warning Alerts

Callout	Occurs At Feet Above Ground Level
RADIO ALTITUDE	2500
TWENTY FIVE HUNDRED	2500
ONE THOUSAND	1000*
FIVE HUNDRED	500
FOUR HUNDRED	400
THREE HUNDRED	300
TWO HUNDRED	200
APPROACHING MINIMUMS	MDA, DH+80
APPROACHING DECISION HEIGHT	MDA, DH+100
PLUS HUNDRED	MDA, DH+100
FIFTY ABOVE	MDA, DH+50
MINIMUM	MDA, DH
MINIMUMS MINIMUMS	MDA, DH
DECISION HEIGHT	MDA, DH
DECIDE	MDA, DH
ONE HUNDRED	100
EIGHTY	80
SIXTY	60
FIFTY	50
FORTY	40
THIRTY FIVE	35
THIRTY	30
TWENTY	20
TEN	10

Table 19-4 (cont)
TAWS Aural Warning Alerts

Callout	Occurs At Feet Above Ground Level
FIVE	5
* Can be barometric altitude above the field elevation for some aircraft types.	

BAROMETRIC CORRECTION SETTING CHANGE TONE

The flight director reference change aural tone is played when any of the following barometric correction parameters begins to change.

- The pilot barometric correction from air data system 1
- The copilot barometric correction from air data system 1
- The pilot barometric correction from air data system 2
- The copilot barometric correction from air data system 2.

The flight director reference change aural tone is played according to the priority defined in the vehicle monitoring system specifications.

No additional reference change tones are permitted due to the barometric correction setting changes. The setting changes during the period of when the barometric correction setting is changing and the five seconds following the completion of all parameters of the barometric correction setting change.

Mode 6 Excessive Bank Angle

An excessive bank angle warning is given based upon radio altitude, roll attitude, and roll rate. The **BANK ANGLE** aural warning, shown in Figure 19-23, is given twice and then suppressed until the roll angle increases by an additional 20%.

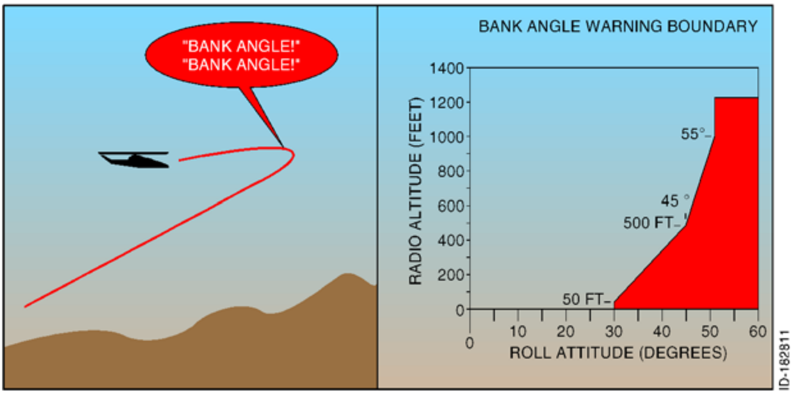


Figure 19-23
Mode 6 Excessive Bank Angle

Mode 6 Tail Strike

A tail strike warning function is given for applicable rotary wing aircraft based upon radio altitude, pitch attitude, pitch rate, and barometric altitude rate. The aural message **TAIL TOO LOW** is given continuously while within the warning boundary. Unique warning boundaries are given for applicable aircraft types. The typical warning boundaries are shown in Figure 19-24.

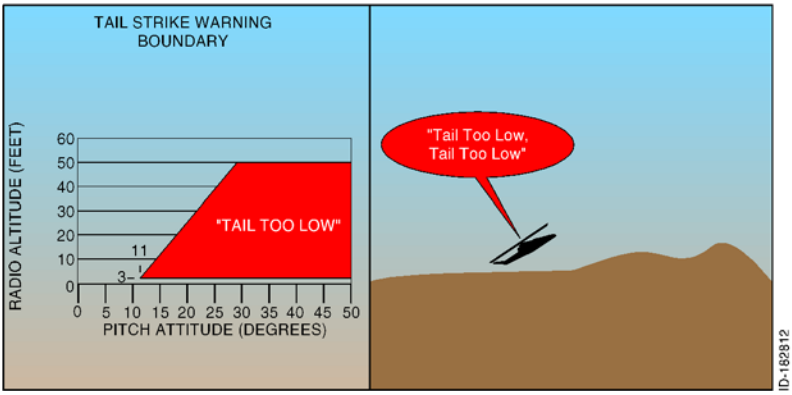


Figure 19-24
Mode 6 Tail Strike Warning

GPWS Failure

Failure of the nondatabase modes results in a **GPWS INOP** annunciator.

Autorotation

TAWS uses engine torque sensing to detect an autorotation. Callouts during autorotation are selected by the way of a menu. If the gear is not down by 400 feet, the pilot hears **TOO LOW, GEAR**.

NOTE: Installation without a torque interface cannot detect autorotation, does not alter the **TOO LOW, GEAR** warning altitude, and autorotation callouts are not given.

NORMAL PROCEDURES

Self-Test

Prior to flight, TAWS must be tested for proper operation. Normally, this is done by the pilot during the before takeoff check. This is done once all aircraft power and systems are up and running and the TAWS GPWS INOP and TERR INOP annunciators are OFF.

NOTE: Because the MK XXII requires GPS information to operate, it generally takes two to five minutes after power-up before the aircraft (or internal) GPS system has acquired satellites sufficient for proper operation. When this condition is satisfied, the MK XXII TERR INOP annunciator turns OFF.

The TAWS self-test is initiated by momentarily pushing the self-test button from the MENU 1/2 page on the MCDU. The self-test results are annunciated at 6 decibels lower than the normal audio level selected for the aircraft, by the way of the same audio system as the EGPWS alerts.

The self-test has six levels which are as follows:

- Level 1 = Go/No Go Testing - This gives an overview of the current operational functions selected and gives an indication of their operational status.
- Level 2 = Current Faults - This gives a listing of the internal and external faults currently detected by the EGPWC.
- Level 3 = EGPWS Configuration - This indicates the current configuration by listing the current hardware, software, databases and configuration module options detected by the EGPWS.
- Level 4 = Fault History - This gives a historical record of the faults both internal and external detected by the EGPWS.
- Level 5 = Warning History - This gives a historical record of the warnings and cautions given by the EGPWS.
- Level 6 = Discrete Test - This gives annunciation of discrete input transitions to be used for maintenance support.

To expedite the navigation of self-test levels and information, two types of cancel sequences are supported. Pushing and holding the cockpit self-test button for less than two seconds is considered a short cancel. Pushing and holding the cockpit self-test button for more than two seconds is considered a long cancel.

Self-test is inhibited if TAWS detects an in air condition. Short Level 1 self-test is intended to supply a confidence, Go/No Go, test to show that the EGPWS is fully operational. The amber TERR INOP and GPWS INOP annunciate and remain annunciated for the duration of the test.

The amber GPWS annunciator turns ON and the aural callout **GLIDESLOPE** is issued. The amber GPWS annunciator turns OFF. The amber G/S CANCEL annunciator turns ON momentarily. The red GPWS annunciator turns ON and the aural callout **"PULL UP** is issued. The terrain display test pattern is shown for 12 seconds. The aural callout **WARNING TERRAIN** is issued. The red GPWS annunciator turns OFF, followed by the amber GPWS annunciator turning ON briefly. After that, the terrain display test pattern is removed and the amber TERR INOP and GPWS INOP annunciators extinguish.

This sequence indicates a proper and successful Level 1 self-test. The long Level 1 self-test is initiated by pressing and holding the cockpit self-test button until self-test aurals start. This test gives the GO/NO GO, then issues all configured aurals.

Level 2 self-test is initiated by pushing the cockpit self-test button within three seconds of the end of the Level 1 self-test. During Level 2 self-test, a short cancel or long cancel terminates the self-test level and PRESS TO CONTINUE is annunciated for proceeding to Level 3 self-test.

NOTE: In some installations the annunciators turn OFF after two seconds andt the LOW ALT annunciator turns ON momentarily.

Recommended Procedures (Warnings in Flight)

PULL UP If in visual conditions during the day:

1. Evaluate aircraft flight path with respect to terrain.

2. Take corrective action as necessary to recover safe terrain clearance.

3. Advise Air Traffic Control as necessary.

If in instrument conditions or at night where visual judgement of the situation is not assured:

1. Roll to 0 degrees of bank and simultaneously pitch up to the best angle of climb attitude and speed of the aircraft.

2. Apply maximum collective allowable.

3. Continue maximum climb until all visual and aural warnings cease.

4. Advise Air Traffic Control, as necessary.

Along with CAS messages, an AWG generates a series of aural messages that are listed in Table 19-5.

Table 19-5
Aural Messages

Aural Message	Meaning
TERRAIN, TERRAIN **PULL UP**	**Condition:** Aircraft flight path is in conflict with raising terrain **Action:** Adjust flight path as required away from threat until alert ceases.
CAUTION TERRAIN or **CAUTION OBSTACLE**	**Condition:** Aircraft flight path is in conflict with terrain/obstacle. **Action:** Adjust flight path as required away from threat until alert ceases.
WARNING TERRAIN or **WARNING OBSTACLE**	**Condition:** Aircraft flight path is in conflict with terrain/obstacle. **Action:** Adjust flight path as required away from threat until alert ceases.
TOO LOW TERRAIN or **TOO LOW GEAR**	**Condition:** Insufficient terrain clearance for phase of flight. **Action:** Adjust flight path to recover safe terrain clearance until alert ceases.
DON'T SINK	**Condition:** Aircraft is losing altitude during take-off/climb or missed approach. **Action:** Re-establish positive rate of climb.
SINKRATE	**Condition:** Rate of descent is excessive for current height above terrain. **Action:** Reduce rate of descent.

Table 19-5 (cont)
Aural Messages

Aural Message	Meaning
PULL UP	**Condition:** Rate of descent is excessive for current height above terrain. **Action:** Reduce rate of descent.
BANK ANGLE, BANK ANGLE	**Condition:** High roll attitude at low altitude **Action:** Decrease roll attitude.
TAIL TOO LOW	**Condition:** High nose attitude-tail very close to ground. **Action:** Lower nose or increase altitude.
ALTITUDE, ALTITUDE	**Condition:** Flight below DH with gear up or Low Altitude mode active. **Action:** Verify aircraft altitude.

The highest priority aural message takes precedence and immediately interrupts any lower priority message, as listed in Table 19-6 . If the aircraft is in a situation that meets more than one condition for an alert or warning at the same time, the higher priority message is heard until that condition is resolved.

If the lower priority condition is still in effect at that time, the lower priority aural message is heard. Only one message is produced at any one time.

Table 19-6 lists the aural output that is activated for each callout, caution and warning condition. The messages are arranged from highest priority at the top, to lowest priority at the bottom of the table.

Table 19-6
Aural Message Priorities

ALERT/WARNING CONDITION	AUDIO MENU	NOTES
MODE 1 PULL UP	PULL UP	1, 3
MODE 2 PULL UP PREFACE	TERRAIN TERRAIN	1, 2

Table 19-6 (cont)
Aural Message Priorities

ALERT/WARNING CONDITION	AUDIO MENU	NOTES
MODE 2 PULL UP	PULL UP	1, 3
TERRAIN AWARENESS PREFACE	WARNING TERRAIN	1, 2
TERRAIN AWARENESS WARNING	WARNING TERRAIN	1, 3
OBSTACLE AWARENESS PREFACE	WARNING OBSTACLE	1, 2
OBSTACLE AWARENESS WARNING	WARNING OBSTACLE	1, 3
MODE 2 TERRAIN	TERRAIN	
MODE 6 MINIMUMS	MINIMUMS - MINIMUMS	
MODE 6 ALTITUDE	ALTITUDE - ALTITUDE	
TERRAIN AWARENESS CAUTION	CAUTION TERRAIN (PAUSE) CAUTION TERRAIN	4
OBSTACLE AWARENESS CAUTION	CAUTION OBSTACLE (PAUSE) CAUTION OBSTACLE	4
MODE 4 TOO LOW TERRAIN	TOO LOW TERRAIN	
MODE 6 ALTITUDE CALLOUTS	SELECTED CALLOUTS	
MODE 4 TOO LOW GEAR	TOO LOW GEAR	

Table 19-6 (cont)
Aural Message Priorities

ALERT/WARNING CONDITION	AUDIO MENU	NOTES
MODE 1 SINKRATE	SINKRATE	5
NOTE: The basic warning is **SINKRATE (PAUSE) SINKRATE**. However, if the Mode 1 pull-up curve is violated, only a single **SINKRATE** occurs prior to the pull up voice.		
MODE 3 DON'T SINK	DON'T SINK (PAUSE) DON'T SINK	
MODE 5 GLIDESLOPE	GLIDESLOPE	
MODE 6 BANK ANGLE	BANK ANGLE, (PAUSE) BANK ANGLE	
MODE 6 TAIL STRIKE	TAIL TOO LOW	
TA&D INVALID ALERT	BE ALERT TERRAIN INOP	
NOTES: 1. These are the only aurals that can interrupt. 2. The preface aurals always are given prior to the warning aural. 3. Aural message is continuous. 4. Aural messages repeat every 10 seconds. 5. Long self-test only issues a single **SINKRATE**.		

Limitations

1. **Low Altitude** must not be engaged during IFR flight except as required for certain instrument approaches to offshore platforms.

2. **Low Altitude** decreases the terrain look down angle. The EGPWS uses greater than 50 knots as an indication of transition to forward flight with the intent of departure from the landing zone or airport. For local maneuvering in excess of 50 knots, it is recommended that **Low Altitude** be selected.

3. TAWS must have an operating source of GPS information, with enough satellites in view to give GPS data within the accuracy requirements of the system.

4. Without the optional outside air temperature (OAT) input for corrections, geometric altitude creates errors during rapid climbs or descents in non-international standard atmosphere conditions. This affects alerting/warning times and proper altitude reference on the terrain display.

5. The terrain, obstacle and runway/helipad database information is not all-inclusive.

6. Wires are not included in the database.

7. Airspeeds referred to in this guide are GPS ground speed or calibrated airspeed from the air data computer and is not a precise match of cockpit indications.

Database Update Procedures

Load the personal computer memory card international association (PCMCIA) database card as described in the paragraph below. Loading time is approximately 70 minutes.

1. Load the PCMCIA database card with the EGPWS mounted in the aircraft.

2. Connect the Smart Cable (Honeywell PN 951-0386-001) to the EGPWS J3 connector.

3. Ensure that the 28 V dc circuit breaker to the EGPWS in ON and that the green **COMPUTER OK LED** annunciator on the EGPWS front panel is ON.

4. Insert the PCMCIA card into the smart cable PCMCIA card slot.

NOTE: Precautionary notes on the PCMCIA card, regarding insertion and/or removal while power is applied, must be ignored since the EGPWS automatically handles the application and removal of PCMCIA card power.

5. While the loading is in progress, the amber **IN PROG LED** on the smart cable remains ON and the green **COMPUTER OK LED** annunciator on the EGPWS is OFF.

6. When loading is complete the green **XFER COMP LED** annunciator on the smart cable turns ON.

7. Remove the PCMCIA card from the smart cable slot.

8. After approximately 15 seconds, the green **COMPUTER OK LED** annunciator comes ON to indicate that the contents of the PCMCIA card were successfully transferred.

9. Remove the smart cable connector from the EGPWS front panel J3 connector.

20. Central Maintenance Computer (CMC)

INTRODUCTION

MAU 1 contains the central maintenance computer (CMC) module that maintains a continuously recorded log of the following parameters:

- Faults
- Exceedance of limitations
- Cumulative log.

When the aircraft is on the ground, the pilot can display logged information on the MFD by selecting the maintenance page in the system menu with the cursor control device (CCD). Logged information can be displayed to maintenance personnel when the helicopter is on the ground using the portable maintenance access terminal (PMAT).

FAULT LOG

Each time the MAU is powered up, a fault report is generated. At shutdown the fault report is edited and any failure condition detected during the mission is logged in the fault log.

The fault log contains the fault history database (FHDB), where all maintenance messages are saved and can be displayed on the MFD or PMAT as one of the following:

- Present flight leg messages
- Active maintenance messages
- Fault history messages
- Fault history by date messages.

The maintenance message record maintained in the fault log contains, at a minimum, the following information:

- Helicopter ID
- Fault record number
- Date (DD:MM:YY)
- Time (HH:MM:SS)
- Flight leg

- Flight phase
- Avionic line replaceable unit (LRU) serial number (if available)
- Failure message in plain text
- Failure duration (HH:MM:SS)
- Occurrence number.

EXCEEDANCE LOG

Each time the MAU is powered up, if at least one exceedance event is detected during the mission, a new exceedance log is generated and displayed on the MFD during engine shutdown only.

Exceedances requiring the immediate attention of the pilot, such as HOT START, ENGINE OVERSPEED or TRANSMISSION OVER TORQUE are displayed in the MFD message display at the time they happen.

CAUTIONS displayed to the pilot are stored in the fault log, while the peak and duration of each event is stored in the exceedance log.

The following exceedance events are recorded by the CMC.

- ITT limits exceeded
- Hot start limits exceeded
- Torque (TQ) limits exceeded
- Compressor speed (NG) limits exceeded
- Turbine speed (NF) limit exceeded
- Rotor speed (NR) limits exceeded.

NOTE: Refer to Agusta Rotorcraft Helicopter Flight Manual, Pub No. 139G0290X002 for the specific limitations related to each of the above.

GENERAL EXCEEDANCE LOG ADDITIONAL REQUIREMENTS

The following applies:

- Ground condition

  - No exceedance recording is performed on the NR signal during engine start-up or shutdown.

  - The exceedance recording of each engine parameter (such as, Hot Start, NF Overspeed) occurs while the helicopter is either on the ground or airborne.

CUMULATIVE LOG

Each time the MAU is powered-up, a new flight leg log (this flight) is generated. It is only displayed at engine shutdown.

The cumulative log function retains the following information:

- Helicopter ID
- Date (DD:MM:YY)
- Time (HH:MM:SS)
- Flight time (this flight and cumulative)
- Engine one and Engine two running time (this flight and cumulative)
- Number of Engine one and Engine two starts (this flight and cumulative)
- Engine one and Engine two low cycle fatigue (LCF) and blade creep counters (this flight and cumulative)
- Rotor running time (this flight and cumulative)
- Number of rotor starts (this flight and cumulative)
- Number of rotor brake applications (this flight and cumulative)
- Number of landings (this flight and cumulative)
- Engine one and Engine two chip detectors activations (this flight and cumulative)
- Main, intermediate, and tail gearbox chip detectors activations (this flight and cumulative)
- Number of chip burner activations (this flight and cumulative).

The helicopter ID is stored in the configuration module of the MAU and entered into the cumulative log automatically.

The partial (this flight) time counters function according to the following parameters.

NOTES: 1. The helicopter enters ground mode at the landing when sufficient weight is transferred from the rotor system to the landing gear to close the weight-on-wheels (WOW) switch and rotor speed (NR) is reduced to less than 40%.

2. The helicopter enters flight mode when the WOW switch opens.

- The flight time counter starts at takeoff when the flight mode becomes active and stops only when ground mode becomes active.
- The landing counter advances each time the WOW switch closes.
- The Engine one and Engine two running time counters start when the corresponding compressor speed (NG) is greater than 12% during start-up and stops when NG drops below 50%.

This Flight Counters

The partial (this flight) time counters are in increments according to the following requirements:

- The flight time counter starts running up when the aircraft is in flight and it stops running only when the aircraft is on the ground

  NOTE: If the aircraft takes off after a landing was performed without any engine shutdown, the counter resumes its operation from the last value until NR <40%.

- The landing counter are in increments whenever the transition from flight to ground.
- The Engine 1 and Engine 2 running time counters start running up when the corresponding NG >12% and stop running when NG <50%.
- The Engine 1 and Engine 2 start counters are incremented whenever the corresponding NG >12%.

- The rotor running time starts running when NR >20% and stops when NR <20%.
- The rotor start counter increments when NR >20%.
- The rotor brake counter increments when the corresponding input is active.
- The chip detector counters increment when the corresponding input is active.
- The chip burner counter increments when the corresponding input is active.

CMC Display on the MFD

Figure 20-1 shows the display pages on the MFD. The CMC MAIN MENU page includes:

- Maintenance Messages
- System Diagnostics
- Extended Maintenance
- Data Loader.

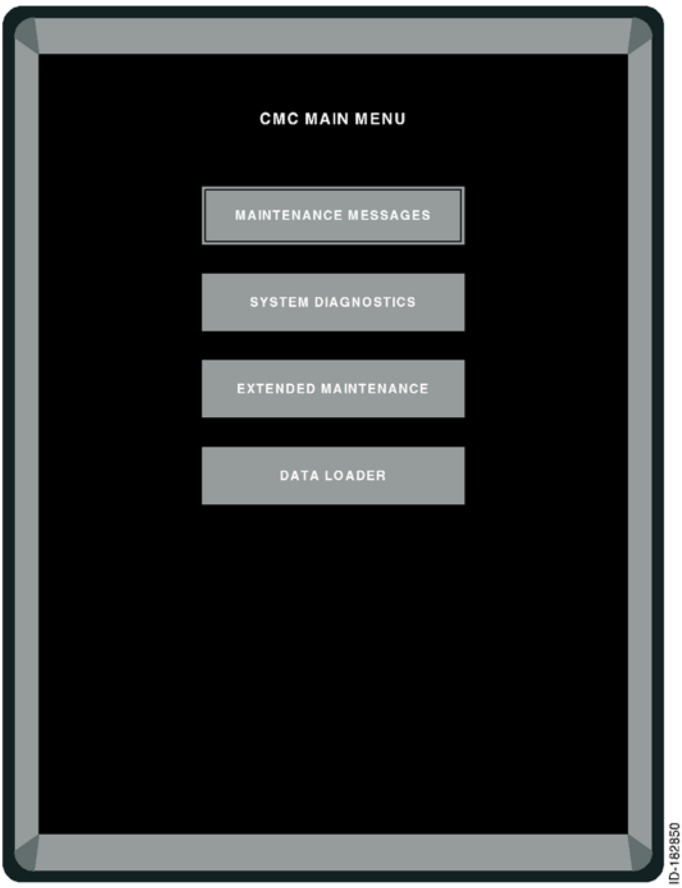


Figure 20-1
Typical CMC Main Menu

By selecting an option, the pilot or maintenance personnel opens the page associated with the button.

Once the aircraft is airborne, the **IN-AIR MENU** is displayed. This menu shows fewer options, as shown in Figure 20-2.

Figure 20-2
Typical In-Flight CMC Display

Blank Page

Acronyms and Abbreviations

Acronyms and abbreviations used in this Pilot's Guide are defined as follows:

TERMS	DEFINITION
A	alpha auto
ACDB	aircraft database
ADA	air data application
ADC	air data computer
ADF	automatic direction finder
ADI	attitude direction indicator attitude director indicator
ADLP	airborne datalink processor
ADM	air data module
ADS	air data source air data system
AEO	all engines operating
AF	arc to a fix
AFC	automatic flight control
AFCS	automatic flight control system
aft	after
AGC	automatic gain control
AGL	above ground level
AHRS	attitude and heading reference system
AHRU	attitude and heading reference unit
AIOP	actuator input/output with processor
alpha	alphabetical
ALT	altitude
Alt	alternate
ALT SEL	altitude select
ALTA	altitude
ALVL	autolevel
AM	amplitude modulation
AMLCD	active matrix liquid crystal display
AMM	air management module
amps	amperes
ANSI	American National Standards Institute
ANT	antenna
AOA	angle-of-attack

TERMS	DEFINITION
AOG	aircraft on ground
AP	autopilot
API	applications programming interface
APM	aircraft personality module
APP	approach
ARINC	Aeronautical Radio Incorporated
ASCB	avionics standard communications bus
ASCB-D	avionics standard communication bus - digital
ASEL	altitude preselect
ASL	above sea level
ATC	air traffic control
ATCRBS	air traffic control radar beacon system
ATT	attitude
AUTH	authorize
AUTO	automatic
AUX	auxiliary
AW	aural warning
AWG	aural warning generator
AZ	azimuth
BAB	bank angle bias
BARO	barometric
BARO-ALT	barometric-altitude
BATT	battery
BC	back course
BCN	beacon
BFO	beat frequency oscillator
BIC	backplane interface controller
BIT	built-in test
BITE	built-in test equipment
BKUP	backup
BLT	belt
BOD	bottom of descent
BOSC	bottom-of-step climb
BOW	basic operating weight
BRG	bearing
BRT	bright
C	center
	centigrade

TERMS	**DEFINITION**
	Celsius
C/A	commercial access
CA	cabin audio
CAB	cabin
CALF	control abstraction layer function
CAN	controller area network
CAS	crew alerting system
CB	circuit breaker
CCD	cursor control device
ccw	counterclockwise
CDB	custom database
CDI	course deviation indicator
CF	course to a fix
CFIT	controlled flight into terrain
CG	center of gravity
CHAN	channel
CHK	check
CHM	chime
CIO	control input/output
CIOCAL	control input/output controol abstraction layer
CLR	clear
CLTV	collective
CMC	central maintenance computer
CMS	configuration management system
CNTL, CNTRL	control
COM, COMM	communication
Config, CONFIG	configuration
CPA	closest point of approach
CPL	couple
CR	clutter reduction
CRC	Customer Response Center cyclic redundancy check
CRS	course
CSIO	custom input/output
Ctrl	control
CVR	cockpit voice recorder
CW	continuous wave
cw	clockwise
D8PSK	differential eight phase shift keying

TERMS	DEFINITION
DAC	digital to analog converter
DADS	digital air data system
DB	database
dB	decibel
DBM	database module
DC	display controller
dc	direct current
DCL	deceleration
DD:MM:YY	day:month:year
DDM	difference in depth modulation
DECEL	decelerate
deg/sec	degrees per second
DEL	delete
DEOS	digital engine operating system
DEV	deviation
DF	direction finder
DG	directional gyro
DH	decision height
DIR	direct
DISP	display
DLS	data loading system
DME	distance measuring equipment
dps	degrees per second
DR	dead reckoning
DSP	display
DTK	desired track
DU	display unit
E	East
EASA	European Aviation Safety Agency
EDS	electronic display system
EEC	electronic engine controller
EEPROM	electrically erasable programmable read-only memory
EFIS	electronics flight instrument system
EGPWC	enhanced ground proximity warning computer
EGPWS	enhanced ground proximity warning system
EHSI	electronic horizontal situation indicator
EICAS	engine instrument and crew alerting system
EL	elevation

TERMS	DEFINITION
EM	emission emission mode
EMER, EMRG	emergency
ANAC	Ecole Nationale de l'aviation Civile
ENG	engine
EP	electrical pump
EPROM	electrically programmable read only memories
EPU	estimated position uncertainty
ESS	essential
ETA	estimated time of arrival
ETD	estimated time of departure
ETE	estimated time en route
ETL	effective translational lift
EUR	Europe
EXT PWR	external power
FA	course to an altitude
FAF	final approach fix
FC	fault code
FCU	fuel computer unit
FD	flight director
FDR	flight director recorder
FF	fuel flow
FGS	flight guidance system
FHDB	fault history database
FL	flight level
FLIR	forward looking infrared radar
FLT	flight
FLT ID	flight identification
FM	frequency modulation
FMS	flight management system
FOG	fiber optic rate gyro
FOM	figure of merit
fore	before
FP, FPL, FPLN	flat panel flight plan flight planning
FPGA	field-programmable gate array
fpm	feet per minute
FREQ	frequency

TERMS	DEFINITION
FSBY, FSTBY	forced standby
ft	feet
ft/min	feet per minute
FTR	force trim release
G	gain
g	acceleration of gravity
G/S, GS	glideslope ground speed
GA	go-around
GC	guidance controller
GCR	ground clutter reduction
GCU	generator control unit
GEN	generator
GGF	graphics generation function
GIO	generic input/output
GMAP	ground mapping
GND PROX	ground proximity
GPS	global positioning system
GPWS	ground proximity warning system
HA	holding pattern to an altitude termination heading
Hbc	baro corrected altitude
HDG	heading
HDPH	headphone
HF	high frequency holding pattern to a fixed waypoint
HF COMM	high frequency communications
HFOM	horizontal figure of merit
HH:MM:SS	hour:minute:second
HI/LO	high/low
HIL	horizontal integrity limit
HM	holding pattern with manual termination
HOLDA	hold acknowledge
HOV	hover
Hp	pressure altitude
hPa	hectopascals
hr	hour
HR	altitude rate

TERMS	DEFINITION
HS	heading select
HSI	horizontal situation indicator
HVPS	high voltage power supply
HYD	hydraulic
Hz	Hertz
I	inner
I/O	input/output
IAF	initial approach fix
IAS	indicated airspeed
IBIT	initiated built-in test
ICAO	International Civil Aviation Organization
ICS	intercom system
ID, IDENT	identification
Idents	identifiers
IF	initial fix
IFR	instrument flight rules
IGB	intermediate gear box
IHBT	inhibited
ILS	instrument landing system
INH, INHIB	inhibit
inHg	inches of mercury
INIT	initialization
INPH	interphone
Int	interrupt
IOP	inoperative
IRS	inertial reference system
ITT	inlet turbine temperature internal turbine temperature interturbine temperature
ITU	International Telecommunication Union
kb/s	kilobit per second
KCAS	knots calibrated airspeed
KG, kgs	kilograms
kHz	kilohertz
KIAS	knots indicated airspeed
kts	knots

TERMS	DEFINITION
L	left
LAAD	low altitude awareness display
LAAS	local area augmentation system
LAN	local area network
LAT/LON	latitude/longitude
Lat/Vert	lateral/vertical
lbs, LB	pound(s)
LCD	liquid crystal display
LCF	low cycle fatigue
LD	lower sideband data
LG	large lateral guidance
LNAV	lateral navigation
LO	low
LOC	localizer
LP	lightning processor
LRM	line replaceable module
LRU	line replaceable unit
LSK	line select key
LSS	lightning sensor system
LV	lower sideband voice
LVDT	linear variable differential transformer
LX	lightning
M	manual meters middle
m, min	minute
MAG	magnetic
MAHWP	missed approach holding waypoint
MAINT	maintenance
MAN	manual
MAP	missed approach point
MAU	modular avionics unit
Mb/sec	megabit per second
MCDU	multifunction control display unit
MCP	maximum continuous power
MDA	minimum descent altitude
MED	medium
MEM	memory

TERMS	DEFINITION
MES	Middle East
MFD	multifunction displays
MG, MGB	main gear box
MGT	management
MHz	megahertz
MIC	microphone
MICSTK	microphone stuck
min	minute(s)
MIN	minimum
MKR	marker
MKR BCN	marker beacon
MKR SENS	marker sensor
mm	millimeters
mm/hr	milimeters per hour
MON	monitor
MOT	mark on target
MPEL	maximum permissable exposure level
MRC	modular radio cabinet
MSCP	miscompare
MSG	message
MSL	mean sea level
MSU	magnetic sensor unit
MT	mounting tray
MTBF	mean time between failures
MW	monitor warning
MWF	monitor warning function
MWL	master warning light
MWS	monitoring warning system
N	North
	numeric
N/A	not available
NAM	North America
NAV	navigation
NAVAID	navigation aid
NAVSTAR	navigation system with time and ranging
NCD	no computed data
NDB	navigation database
NEG	negative
NF	power turbine speed

TERMS	DEFINITION
NG	compressor speed
NI	network interface
NIC	network interface controllers
NIC/PROC	network interface controller with processor
NIM	network interface module
NM	nautical mile(s)
No.	number
NORM	normal
NOTAM	notice to airmen
NR	main rotor speed
NS	navigation
NTSC	National TelevisionStandards Committee
NWS	National Weather Service
O	outer
OAT	outside air temperature
OEI	one engine inoperative
OEI TNG	one engine inoperative - training
OP	operational
OSC	oscillator
OT	other traffic
P/B/D	place/bearing/distance
P/B/P/B	place/bearing/place/bearing
PA	public address
PAC	Pacific
PAL	programmable array logic
PAST	pilot-activated self-test
PCI	peripheral component interconnect
PCMCIA	Personal Computer Memory Card International Association
PDD	periodic device driver
PEP	packet exchange protocol
PERF	performance
PFD	primary flight display
PFN	pulse forming network
PI	power index
PMAT	portable maintenance access terminal
POC	power on count

TERMS	DEFINITION
POST	power-on self-test
PPOS	present position
PRAIM	predictive receiver autonomous integrity monitor
PRES-ALT	pressure-altitude
PRESS	pressure
PREV	previous
PRF	pulse repetition frequency
PROC	processor
PROG	progress
PRV	preview
PS	power supply
Ps	static pressure
psi	pounds per square inch
PT	proximate traffic
Pt	total pressure
PTT	push-to-talk
PWM	pulse width modulated
Pwr, PWR	power
Qc	impact pressure
Qd	dynamic pressure
R	remote right
R/T	receiver/transmitter
RA	radio altitude, resolution advisory
RAD, RA	radio
radalt	radio altitude
RAIM	receiver autonomous integrity monitor
RAM	random-access memory
RC	reduced carrier
RCB	radio control buses
RCP	reconfiguration control panel
RCT	rain compensation technique
RCVR	receiver
REACT	rain echo attenuation compensation technique
REF	reference
REG	register

TERMS	DEFINITION
RF	precision arc radio frequency
RFM	rotorcraft flight manual
RHT	radar altimeter hold radar altitude hold radar height
RI	remote instrument
RIB	remote image bus
RIC	remote instrument controller
RICP	remote instrument controller panel
RMA	return material authorization
RMI	radio magnetic indicator
RNG	range
RNIC	Radio Network Interface Controller
RNP	required navigation performance
rpm	revolution per minute
RPROC	Radio Processor
RTA	receiver transmitter antenna
RTCA	Radio Technical Commission for Aeronautics
RX	receiver
S	South
SA	selective availability
SAR	search and rescue
SART	Search and Rescue Radar Transponder
SAS	stability augmentation
SAT	static air temperature
SATCOM	satellite communications
SBH	side band high
SBL	side band low
SBY, STBY	standby
SCI	serial control interface
SCMS	system configuration monitor system
SCR	sea clutter reduction
sec	seconds
SECT	sector
SELCAL	select calling
SID	standard instrument departures
SLV	slave
SMK	smoking

TERMS	DEFINITION
SMPL	Simplex
SOV	shut off valve
SP	space
SPA	South Pacific
SPD	speed
SPEX	spares exchange
SPLT	split
SQ	squelch
SQH	squelch high
SQL	squelch low
SQNO	squelch noise
SSEC	static source error correction
STAB, STB	stabilizer
STAR	standard terminal arrival route
STC	sensitivity time control
SUSPD	suspend
SYNC, syncs	synchronize(s)
Sys, SYS	system
TA	traffic advisory traffic alert
TACAN	tactical air navigation
TAD	terrain alerting and display
TAS	true airspeed
TAT	total air temperature
TAWS	terrain alert warning system
TCAS	traffic alert and collision avoidance system
TD	transition down
Temp, TEMP	temperature
TERR	terrain
TF	track to a fix
TGB	tail gear box
TGT	turbine gas temperature
TKE	track angle error
TO	takeoff
TOC	top of climb
TOD	top of descent
TQ	torque
tritach	triple tachometer
TRSOV	tail rotor shut off valve

TERMS	DEFINITION
TRU	transformer rectifier unit
TSO	technical standard order
TST	test
TTFF	time-to-first-fix
TTS	time to station
TURB	turbulence
TX	transmitter
UCPL	uncoupled
UD	upper sideband data
UNCAL	uncalibration
USA	United States of America
UTC	universal time constraint
UTIL SOV	utility shut off valve
UV	upper sideband voice
V	VOR/LOC volts
V dc, VDC	volts direct current
VA	heading to an altitude
V_{APP}	VOR approach
VAR	variable
VbPCI	virtual backplane peripheral component interconnect bus
Vc	calibrated airspeed
VCE	voice
VDI	vertical deviation indicator
VDL	VHF datalink
VDR	VHF data radio
VFOM	vertical figure of merit
VFR	visual flight rules
VG	vertical gyro
VGN	variable gain
VGP	vertical glidepath
VHF	very high frequency
Vi	indicated airspeed
VI	heading to an intercept
VIDL	VHF omni directional radio and instrument landing
VIL	vertical integrity limit

TERMS	**DEFINITION**
VIP	video integrated processor
VM	heading to a manual termination
VMS	vehicle monitoring system
VNAV	vertical navigation
VNAV APP	vertical navigation mode approach
VNAV DEV	vertical navigation mode deviation
V_{NE}	never exceed speed
VOL	volume
VOR	variable omnidirection and ranging very high frequency omni-directional radio range
VOR/LOC	VHF omni-range/localizer
VORTAC	combined VOR and TACAN stations
VOX	voice-activated squelch
VP, VPTH	vertical path
VS	vertical speed
VSI	vertical speed indicator
VTA	vertical track
VY	best rate of climb speed
W	watt West
WAAS	wide area augmentation system
WOW	weight-on-wheels
WTR	remote winch
WX	weather
WX/TERR	weather radar/terrain
WXR	weather radar

TERMS	DEFINITION
XMIT	transmit transmitter
XMIT INH	inhibit transmissions
XMITTER, XMTR	transmitter
XPDR	transponder
XREF	cross reference
XTK	crosstrack

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